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23. DAIRY TECHNOLOGY

Unit 1: Market Milk, Unit operations in Milk & Dairy Products Processing and Dairy Beverages
Status of dairy industry in India. Recent policies related to dairy sector (National and International). NPDD and DIDF and other schemes for dairy development. Principles and practices for production of high quality milk (Clean milk production). Methods of milk procurement, payment, quality assessment, detection of adulterants, contaminants and microbial safety aspects of liquid milk, handling and transportation of milk. Methods of raw milk preservation. physical properties, chemical composition and legal standards of milk of cow, buffalo and other species of milch animals. Centrifugal separation, clarification, bactofugation and bactocatch processes and factors affecting their efficiency. Homogenization process and its implications in dairy processing; theories and efficiency of homogenization and factors affecting the process. Thermal processing of milk. Principles and methods of pasteurization and sterilization. UHT processing and aseptic packaging. Special milks including emerging classes of dairy beverages.

Unit 2: Indigenous Milk Products and Technological Advances in Traditional Dairy Products
Status and role of traditional dairy products in Indian dairy industry and economy. Classification, characteristics, composition, legal standards, yield of various traditional products. Methods of production – conventional, improved and industrial processes; physico-chemical changes during manufacture; quality attributes, factor affecting shelf-life, common defects during storage. Packaging systems of indigenous milk products. Convenience traditional Indian Milk products – production process, packaging and shelf life. Long life TDPS, application of emerging technologies for quality improvement of TDPs including hurdle technology, membrane processing and newer additive, Innovations in formulations and processing of TDPs (Low calorie, Low fat products), equipment for the commercial production of TDPs.

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Unit 3: Technological Aspects of Processed Dairy Products
Fat-rich dairy products: Chemistry of milk fat; Basic principles and recent concepts in production and processing of different types of cream, butter, margarine, fat spreads, butter oil and *ghee*. Fractionation of fat and its application. Mechanization of manufacturing fat rich dairy products. Role of milk fat in human nutrition. Different fat replacers and their mechanism. Rheological properties of fat rich products.
Frozen Milk Products: Trends in the frozen milk products industry in India. National and Global scenario of frozen milk products trade. Definition, classification and composition of ice cream and other frozen desserts. Role of milk constituents and other ingredients, processing steps, packaging and storage methods on quality of ice cream. Technological aspects of manufacture of plain, fruit, soft-serve, low fat and dietetic ice creams and novelties. Indigenous frozen desserts, kulfi, malai-ka-baraf etc.; their production techniques and quality. Storage and distribution of ice cream/frozen desserts. Newer ingredients for use in the ice cream industry. Recent advances in freezing of ice cream/frozen desserts. Different types of freezing techniques and their effect on quality attributes of frozen dairy products.

Concentrated and Dried Milk Products: Milk in relation to processing and manufacture of concentrated and dried milk. Different methods used for milk concentration. Principles and methods of manufacture, storage and defects in sweetened condensed milk. Heat stability of milk. Evaporated milk. UHT sterilized concentrated milk. Manufacturing process and quality aspects of Whole milk powder, Skimmed milk powder, high-fat powders, ice-cream powder and dairy whitener. Instantization of milk powder. Newer technologies and formulations for infant foods and weaning foods, malted milk and malted milk foods.

Unit 4: Advanced Dairy Processing
UHT processed milk products: properties and prospects, equipment, heat stability and deposit formation, effect on milk quality; Principles and equipment for bactofugation and bacto- therm processes; Partial/High Pressure Homogenization and its application in dairy industry; Microfluidization of milk; Concentration processes and their impact on quality of finished products; Advances in drying of milk and milk products; Freeze drying: physico-chemical changes and industrial developments; Hurdle technology and its application in development of shelf-stable products; Use of carbonation in extending the shelf life of dairy products; Advances in bakery processing: Application of dairy ingredients in bakery and confectionary products; Technological aspects and issues in fermented foods and beverages; Extrusion processing of food and dairy products; Advances in cleaning and sanitization of dairy equipment: Bio-films; Bio-detergents; Innovations in sanitizers: chemical, biological, radiation; Assessing the effectiveness of cleaning and sanitization of dairy equipment.

Unit 5: Emerging Technologies for Milk and Milk Products Processing
Non-thermal & Thermal processing technologies for food: Irradiation, High frequency heating, Infra-red (IR) heating, Ohmic heating, Ultrasonic treatment, High hydrostatic pressure processing, Pulsed electric field processing; cold plasma; super critical fluid extraction. Their principles, effect on food constituents and salient applications in food sector/industry; Enzymes in dairy and food processing; Newer concepts in food processing including organic foods; Processing of organic raw material; Genetically modified foods; Space foods; Nutrigenomic, metabolomics and other Omic concepts in dairy and food processing.

Unit 6: Rheology of Dairy Products
Rheological classification and characterization of dairy foods: Shear-rate and time dependence of the flow-curve; Factors affecting flow behaviour; Viscosity of food dispersions: dilute and semi-dilute systems, concentration effects; Dynamic measurement of viscoelasticity; Instrumental measurements: Empirical and fundamental methods; Viscometers: Types and working; Rheometer: principles and operational features; Large Deformations and failure in foods: Texture Profile Analysis; Microstructure of dairy products; Tribology and its applications. Food emulsions; Emulsifiers and their functions in foods; Dairy based foams and their applications, Structure of dairy based emulsions, foams and gels; Blends of stabilizers and emulsifiers.

Unit 7: Cheese and Fermented Milk Products & Biotechnological Application in Dairy Processing
Status and scope of cheese industry. Fermented milk products – their nutritional and therapeutic value. Definition and classification of cheese and fermented milks. Quality of Milk in relation to cheese making. Pre-treatments of milk for cheese making. Cheese Additives. Manufacture of Cheddar, Gouda, Mozzarella and Swiss cheeses. Role of starter cultures in cheese quality. Types of rennet for cheese manufacture. Physical and chemical changes during cheese ripening. Manufacture of processed cheese, cheese spread and cheese foods. Acid coagulated cheeses and whey cheeses. Mechanization of cheese-making process. Modern concepts in accelerated cheese ripening. Storage and defects.
Development and impact of biotechnology on dairy and food industry; Principles of recombinant DNA technique; Production and storage of *dahi,* yoghurt, *shrikhand, lassi* and *misti dohi*. Probiotic dairy products. Preparation and applications of microbial rennet, recombinant chymosin; Exogenous free and microencapsulated enzymes, immobilized enzymes; Production, bio-functional properties and applications of protein hydrolysates; Enzymatic hydrolysis of lactose for preparation of whey and UF-permeate beverages; Bio- preservatives: characteristics and their applications in dairy and food industry.

Unit 8: Membrane Processing for Dairy Applications
Membrane techniques; Classification and characteristics of filtration processes; Types of commercially available membranes; Membrane hardware, design of membrane plants, modeling of ultrafiltration (UF) processes; Membrane fouling-problems and mitigation strategies; Cleaning and sanitization of different types of membranes; Applications of ultrafiltration (UF), reverse osmosis, nano-filtration and microfiltration in the dairy industry; Application of membrane processing techniques for the manufacture of lactose, low lactose milk powder, dairy whiteners, WPC, WPI, MPC, MPI, native micellar casein powder, etc.; Properties and utilization of WPC, WPI, Milk Protein Concentrate (MPC) and Milk Protein Isolate (MPI); Application of membrane processing on quality of traditional dairy products, fermented milks and cheese.

Unit 9: Dairy and Food Packaging
Trends in packaging industry; Testing of packaging materials; Adhesives; Graphics; Coding (Barcode and Quick Response code) and labeling used in food packaging; Protective packaging of foods; Effect of light, oxygen and moisture on packaged food; Packaging of dairy and food products; Modified atmosphere packaging; Shrink and stretch packaging; Self-heating and self-cooling cans; Retort pouch technology; Microwavable, biodegradable, and edible packages; Principles and applications of Active, Smart, Intelligent and Antimicrobial packaging; Industrial packaging: unitizing, palletizing, containerizing, distribution systems for packaged foods; Safety aspects of packaging materials; Sources of toxic materials and migration of toxins into food materials; Interaction of food flavours with packaging.

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Unit 10: Functional Foods, Nutraceuticals, Novel Dairy Ingredients
Milk nutraceuticals and functional foods: Trends, market, classes, mechanisms of action and applications; Milk fortification; Developments in Infant formula and complementary foods; Geriatric Foods, Sports foods; Dairy foods for metabolic disorders; Reduced calorie foods, Low sodium and low lactose foods: Herbs and phytochemicals for fusion health foods; Bioactive ingredients from milk; Probiotic, prebiotic and synbiotic foods. Demineralization of milk and whey. Processing, preservation and value addition of buttermilk and ghee residue. Development / formulation of new products based on dairy byproducts.

Unit 11. Sensory Evaluation of Milk and Milk Products
Introduction, definition, importance and requirements of sensory evaluation. Design of sensory evaluation lab. Physiology of sensory organs and sensory perception. Basic tastes. Various types of sensory receptors, stimulus, and corresponding sensory responses. Definition of terminologies related to sensory evaluation - Thresholds, Mouthfeel, Texture etc. General rules of sensory evaluation. Sensory test methods - Difference, Rating, Sensitivity, and Descriptive tests - procedure, requirements and applications. Advances in sensory techniques- Temporal, Spectral analysis etc., Psychophysical theories. Sensory evaluation of Indigenous and Western dairy products – methods score card, desirable sensory attributes and sensory defects - their causes and prevention.

Unit 12: Management & Food Safety aspects with reference to dairy plant operations Cleaning & Sanitization of dairy plant: Properties of important dairy detergents and sanitizers. Choice of detergents and sanitizers guiding principles and limiting factors. Basic principles in formulating the cleaning and sanitizing procedures for dairy equipment. Automation in cleaning and sanitization processes including CIP. Quality of water in detergency. Advances in cleaning and sanitation viz. biodetergents, etc. Waste Management of dairy plant, Plant operational efficiency including energy, water and waste minimization & auditing, zero waste disposal concepts, Personnel management, Maintenance of dairy processing equipments.

Unit 13: Legal and Quality Management System for Milk and Milk Products
Safety aspects of milk with reference to mycotoxins, antibiotics, pesticides, weedicides and heavy metals. FSSAI, BIS and AGMARK standards for milk and milk products. Quality systems such as HACCP, ISO certification, six sigma, GMP, etc. Other advanced quality management systems applied in dairy and food industry.

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CHAPTER 01

Market Milk, Unit Operations in Milk & Dairy Products Processing and Dairy Beverages

2022

1. Which of the following defines the gross chemical composition characteristic of normal cow milk?
(A) Average fat (4%), lactose (4.8%), and protein (3.3%)
(B) High fat (7%), low lactose (3%), and high protein (5%)
(C) Low fat (1%), high lactose (6%), and low protein (2%)
(D) High fat (8%), high lactose (5%), and low protein (1%)

2016

2. According to FSSAI standards, what is the minimum milk fat and solid-not-fat (SNF) requirement for standardized milk in India?
(A) 1.5% fat and 9.0% SNF
(B) 3.0% fat and 8.5% SNF
(C) 4.5% fat and 8.5% SNF
(D) 6.0% fat and 9.0% SNF

2025

3. What is the average specific gravity of normal cow milk at 15.6 degrees Celsius?
(A) 1.015 to 1.020
(B) 1.028 to 1.032
(C) 1.036 to 1.040
(D) 1.045 to 1.050

2006

4. Which organization was the central implementing agency for Operation Flood in India?
(A) Food Safety and Standards Authority of India
(B) Indian Council of Agricultural Research
(C) Department of Animal Husbanding and Dairying
(D) National Dairy Development Board

2022

5. The National Programme for Dairy Development (NPDD) primarily aims to achieve which of the following objectives?
(A) Exclusively promote the export of indigenous dairy products
(B) Enhance the quality of milk and create dairy infrastructure
(C) Subsidize the importation of exotic cattle breeds
(D) Regulate the pricing of commercial dairy equipment

2023

6. Which on-farm practice is most effective in preventing environmental mastitis and reducing microbial contamination during milking?
(A) Washing teats with untreated well water prior to milking
(B) Delaying milk cooling until all cows are milked
(C) Post-milking teat dipping with an approved sanitizer
(D) Reusing the same udder cloth for the entire herd

2015

7. What is the primary function of a Bulk Milk Cooler (BMC) in the dairy cold chain?
(A) To pasteurize raw milk to destroy pathogens
(B) To separate cream from fat at village stations
(C) To homogenize the milk prior to transportation
(D) To rapidly chill raw milk to 4 degrees Celsius

2012

8. In a two-axis pricing system for milk, on which two parameters is the payment directly based?
(A) Fat and solids-not-fat (SNF) content
(B) Volume of milk and titratable acidity
(C) Total bacterial count and fat content
(D) Specific gravity and lactose content

2005

9. Which platform test is considered a rapid indicator of the heat stability of milk before processing?

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(A) Methylene Blue Reduction Test
(B) Clot on Boiling (COB) Test
(C) Resazurin Test
(D) Gerber Fat Test

2008

10. Consider the following statements regarding synthetic milk:
I. It is prepared by emulsifying vegetable oil with detergent.
II. Urea is often added to falsely elevate the SNF content.
III. It naturally contains normal whey proteins.
Which of the above statement(s) is/are correct?
(A) I and II
(B) II and III
(C) I and III
(D) I, II and III

2007

11. Which method is most commonly employed for the rapid detection of Aflatoxin M_1 residues in raw milk?
(A) Enzyme-Linked Immunosorbent Assay (ELISA)
(B) Gas Chromatography-Flame Ionization Detection
(C) Atomic Absorption Spectroscopy
(D) Gerber Centrifugation

2008

12. The Lactoperoxidase (LP) system for raw milk preservation requires the exogenous addition of which two components?
(A) Sodium chloride and lactic acid
(B) Potassium sorbate and sodium benzoate
(C) Hydrogen peroxide and sodium thiocyanate
(D) Calcium chloride and sodium hydroxide

2016

13. According to Stokes' Law, the terminal velocity of a fat globule in a centrifugal field is directly proportional to which factor?
(A) The viscosity of the skim milk medium
(B) The atmospheric pressure
(C) The temperature of the ambient air
(D) The square of the fat globule radius

2023

14. What is the fundamental principle behind Bactofugation in dairy processing?
(A) Inactivation of bacteria using ultraviolet radiation
(B) Thermal destruction of vegetative cells at 72 degrees Celsius
(C) Removal of bacterial spores using high-speed centrifugation
(D) Disruption of bacterial cell walls using cavitation

2013

15. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R):
Assertion (A): Two-stage homogenization is universally preferred over single-stage homogenization for high-fat milk products.
Reason (R): The second stage valve provides the primary cavitation force required to disrupt fat globules.
Which of the following is correct?
(A) Both (A) and (R) are true and (R) is the correct explanation of (A).
(B) Both (A) and (R) are true but (R) is not the correct explanation of (A).
(C) (A) is true but (R) is false.
(D) (A) is false but (R) is true.

2021

16. The efficiency of milk homogenization is commonly evaluated by determining which of the following?
(A) The refractive index of the milk
(B) The titratable acidity
(C) The specific gravity
(D) The Farrall index

2011

17. In the context of thermal destruction kinetics, what does the D-value represent?
(A) The time required to reduce a microbial population by 90% at a constant temperature
(B) The constant temperature required to destroy all viable microbial spores within 1 minute
(C) The increase in temperature necessary to reduce the thermal death time by a factor of 10
(D) The residual concentration of active alkaline phosphatase enzymes remaining after heating

2001

18. What are the standard time and temperature legally required for High Temperature Short Time (HTST) pasteurization of milk?
(A) 63 degrees Celsius for 30 minutes
(B) 72 degrees Celsius for 15 seconds
(C) 121 degrees Celsius for 15 minutes
(D) 135 degrees Celsius for 2 seconds

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2010
19. A positive Alkaline Phosphatase (ALP) test in pasteurized milk primarily indicates which of the following?
(A) Inadequate pasteurization or post-processing contamination
(B) Extensive chemical adulteration with synthetic milk compounds
(C) Complete destruction of pathogenetic Mycobacterium tuberculosis
(D) Excessive homogenization pressure during milk fat processing

2024
20. Consider the following statements regarding in-bottle milk sterilization:
I. It is a continuous process utilizing plate heat exchangers.
II. It typically operates at 115-120 degrees Celsius for 15-20 minutes.
III. It leads to significant whey protein denaturation.
IV. It imparts a pronounced cooked flavor due to Maillard browning.
Which of the above statement(s) is/are correct?
(A) I, II and III
(B) II, III and IV
(C) I, III and IV
(D) I, II and IV

2024
21. Which ultra-high temperature (UHT) heating method is characterized by the direct injection of steam into milk?
(A) Tubular heat exchange
(B) Uperization
(C) Scraped surface heat exchange
(D) Plate heat exchange

2024
22. Which chemical is universally utilized as the primary sterilant for packaging materials in commercial aseptic packaging systems?
(A) Sodium hypochlorite
(B) Peracetic acid
(C) Hydrogen peroxide
(D) Chlorine dioxide

2019
23. What distinguishes recombined milk from reconstituted milk?
(A) Recombined milk requires addition of vegetable fat and emulsifiers prior to processing.
(B) Reconstituted milk must undergo ultra-filtration and centrifugal separation before packaging.
(C) Recombined milk strictly refers to fluid milk fortified with synthetic vitamins and minerals.
(D) Recombined milk uses butter oil and skim powder, while reconstituted uses whole milk powder.

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2004
24. Which hydrocolloid is predominantly added to chocolate-flavored milk to prevent the sedimentation of cocoa particles?
(A) Carrageenan
(B) Pectin
(C) Gelatin
(D) Sodium alginate

2023
25. Match the dairy beverages in List I with their primary characteristic or ingredient in List II:
List I: (Dairy Beverages)
P. Acidophilus milk
Q. Rivella
R. Kefir
S. Toned milk
List II: (Characteristics)
1. Whey-based beverage
2. Symbiotic culture of bacteria and yeast
3. Probiotic fermentation
4. Standardized to 3.0% fat and 8.5% SNF
(A) P-3, Q-1, R-2, S-4
(B) P-2, Q-4, R-1, S-3
(C) P-3, Q-2, R-1, S-4
(D) P-4, Q-1, R-3, S-2

2016
26. Which mammalian species produces milk with the highest average concentration of Vitamin C?
(A) Cow
(B) Camel
(C) Buffalo
(D) Sheep

2013
27. Under Codex Alimentarius standards, what is the maximum permissible limit for titratable acidity (expressed as lactic acid) in normal fresh cow milk?
(A) 0.10%
(B) 0.14%
(C) 0.18%
(D) 0.25%

2001

28. Which colligative property of milk is most frequently measured to detect the fraudulent addition of extraneous water?
(A) Boiling point elevation
(B) Osmotic pressure
(C) Freezing point depression
(D) Relative vapor pressure

2017

29. The Anand Pattern of dairy cooperatives is characterized by a three-tier structure. What constitutes the middle tier of this system?
(A) Village Dairy Cooperative Societies
(B) State Dairy Federations
(C) The National Dairy Development Board
(D) District Milk Producers' Unions

2014

30. Consider the following policies/schemes:
I. Dairy Processing and Infrastructure Development Fund (DIDF)
II. National Programme for Dairy Development (NPDD)
III. Operation Flood
IV. Rashtriya Gokul Mission
V. Pradhan Mantri Kisan Samman Nidhi (PM-KISAN)
Which of the above schemes primarily and directly target dairy development and infrastructure?
(A) I, II, III and IV
(B) I, II, III and V
(C) II, III, IV and V
(D) I, III, IV and V

2007

31. Which common milk pathogen is specifically associated with post-pasteurization contamination and is capable of psychrotrophic growth?
(A) Mycobacterium bovis
(B) Listeria monocytogenes
(C) Brucella abortus
(D) Streptococcus thermophilus

2006

32. What is the primary advantage of utilizing insulated milk tankers for long-distance transportation of chilled milk?
(A) They actively refrigerate raw milk during transit using mechanical units.
(B) They continuously agitate the milk cargo to prevent any cream separation.
(C) They utilize integrated solar panels to pasteurize the milk en route.
(D) They limit the temperature rise to under 2 degrees Celsius over 24 hours.

2002

33. Richmond's formula is utilized in the dairy industry for calculating which parameter?
(A) Total Solids (TS) from fat and specific gravity
(B) Total bacterial count and microbial colony growth
(C) Pasteurization holding time and thermal profile
(D) Homogenization efficiency and globule disruption

2025

34. During raw milk reception, what indicates a positive result in the 68% Alcohol Test?
(A) A distinct color change to deep blue
(B) A drop in temperature of the milk sample
(C) The formation of distinct flakes or clots
(D) The generation of foam on the milk surface

2010

35. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R):
Assertion (A): The Methylene Blue Reduction Test (MBRT) time is inversely proportional to the bacterial load in raw milk.
Reason (R): High numbers of actively metabolizing bacteria rapidly consume dissolved oxygen, lowering the redox potential and reducing the dye.
Which of the following is correct?
(A) Both (A) and (R) are true and (R) is the correct explanation of (A).
(B) Both (A) and (R) are true but (R) is not the correct explanation of (A).
(C) (A) is true but (R) is false.
(D) (A) is false but (R) is true.

2002

36. The presence of neutralizers in milk, such as sodium carbonate, is chemically detected using which specific reagent?
(A) Iodine solution
(B) p-Dimethylaminobenzaldehyde
(C) Silver nitrate
(D) Rosalic acid

2001

37. Which statement accurately describes the risk of antibiotic residues in raw milk intended for processing?
(A) Antibiotics enhance the shelf life and safety of pasteurized milk.

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(B) Antibiotic residues inhibit starter cultures in cheese and yogurt making.
(C) Antibiotics accelerate the Maillard browning reaction during UHT steps.
(D) Antibiotic residues are completely destroyed by standard HTST processes.

2022
38. Thermization is a mild heat treatment typically applied to raw milk to achieve which specific goal?
(A) Achieving complete thermal sterilization of milk prior to commercial cheese making
(B) Inactivation of heat-resistant proteases and lipases
(C) Extending raw milk storage life by inhibiting psychrotrophic bacterial replication
(D) Denaturation of whey proteins for better yogurt texture

2025
39. In a centrifugal cream separator, what determines the flow dynamics and spatial separation of the skim milk and cream phases?
(A) The physical position of the pasteurization plates
(B) The diameter and size of the homogenization valve
(C) The operating pressure of the incoming steam supply
(D) The relative spacing and angle of the conical discs

2004
40. Consider the following statements regarding the Bactocatch process:
I. It utilizes cross-flow microfiltration technology.
II. It is capable of removing over 99% of bacteria and spores from skim milk.
III. It subjects the entire milk volume to UHT temperatures.
Which of the above statement(s) is/are correct?
(A) I and II
(B) II and III
(C) I and III
(D) I, II and III

2022
41. Which theory of homogenization proposes that fat globules are torn apart by intense turbulent eddies formed in the fluid jet?
(A) Shear theory
(B) Micro-turbulence theory
(C) Cavitation theory
(D) Impact theory

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2016
42. Homogenization typically causes which of the following physicochemical changes in milk?
(A) Decreased whiteness and overall product opacity
(B) Decreased surface tension and increased foaming
(C) Increased tendency for chemical auto-oxidation
(D) Increased rate of gravity cream line formation

2015
43. What is the Z-value in the context of the thermal death time curve?
(A) The temperature increase required to reduce the D-value by a factor of 10
(B) The time required to destroy 90% of the microbial population
(C) The total lethality of the thermal process equivalent to minutes at 121 degrees Celsius
(D) The percentage of holding tube volume that is unheated

2016
44. In an HTST plate heat exchanger, what is the specific function of the regeneration section?
(A) To cool the incoming raw milk supply using chilled utility water
(B) To heat the incoming raw milk supply using pressurized hot water
(C) To pre-heat incoming raw milk using outgoing pasteurized milk
(D) To divert under-pasteurized milk back to the system balance tank

2007
45. Match the milk processing term in List I with its defining component or characteristic in List II:
List I: (Processing Terms)
P. LTLT Pasteurization
Q. Flow Diversion Valve
R. Clarifier
S. Homogenizer
List II: (Characteristics)
1. Centrifugal removal of somatic cells and dirt
2. High-pressure positive displacement pump
3. Batch heating at 63 degrees Celsius for 30 minutes
4. Safety mechanism in HTST systems
(A) P-3, Q-4, R-1, S-2
(B) P-4, Q-3, R-2, S-1
(C) P-3, Q-1, R-4, S-2
(D) P-1, Q-4, R-2, S-3

2006

46. The Maillard browning reaction during milk sterilization occurs primarily between which two milk constituents?
(A) Milk fat lipids and casein micelles
(B) Whey proteins and calcium phosphate
(C) Lactose and the amino groups of lysine
(D) Lactic acid acidity and free lactose

2013

47. Which design of indirect UHT heat exchanger is most suitable for processing highly viscous dairy products to prevent surface burn-on?
(A) Tubular heat exchanger
(B) Scraped surface heat exchanger
(C) Plate heat exchanger
(D) Direct steam injector

2024

48. What is the primary purpose of adding stabilizers like carrageenan to UHT processed milk?
(A) To increase the nutritional value of the milk
(B) To act as a chemical preservative against bacterial spores
(C) To artificially enhance the fat content
(D) To prevent age gelation and phase separation during storage

2015

49. Double toned milk, as per FSSAI regulations, must contain what minimum percentages of fat and SNF respectively?
(A) 0.5% fat and 8.7% SNF
(B) 1.5% fat and 9.0% SNF
(C) 3.0% fat and 8.5% SNF
(D) 4.5% fat and 8.5% SNF

2011

50. Consider the following statements about milk adulteration detection:
I. Iodine solution is used to detect starch.
II. Urease test is used to detect added urea.
III. Picric acid is used to detect gelatin.
IV. Gerber test is used to detect neutralizers.
Which of the above statement(s) is/are correct?
(A) I, II and III
(B) I, III and IV
(C) II, III and IV
(D) I, II and IV

2008

51. Which of the following is considered a functional dairy beverage?
(A) Whey protein beverage with phytosterols
(B) Standardized pasteurized skim milk
(C) Traditional churned sour buttermilk
(D) Recombined pasteurized whole milk

2022

52. Buffalo milk differs from cow milk in several physicochemical properties. Which of the following statements is factual?
(A) Buffalo milk has a significantly lower fat and protein content than cow milk.
(B) Buffalo milk is naturally richer in carotene, giving it a distinct yellow hue.
(C) Buffalo milk contains significantly less calcium and phosphorus than cow milk.
(D) Buffalo milk has more saturated fatty acids and larger sized fat globules.

2025

53. What is the primary cause of a low freezing point depression (closer to 0 degrees Celsius) in a milk sample?
(A) High somatic cell count
(B) Adulteration with water
(C) High fat content
(D) Prolonged storage at room temperature

2010

54. India ranks first in global milk production. Which dairy species contributes the highest percentage to India's total milk production?
(A) Indigenous cow breeds
(B) Exotic/Crossbred cows
(C) Buffaloes
(D) Goats

2024

55. Select the correct sequential order of standard operations in a commercial HTST pasteurization plant.
(A) Reception → Homogenization → Chilling → Pasteurization → Storage
(B) Reception → Clarification → Pasteurization → Homogenization → Chilling
(C) Clarification → Chilling → Homogenization → Reception → Pasteurization
(D) Pasteurization → Clarification → Reception → Chilling → Homogenization

2017

56. Which of the following hygienic practices specifically prevents the transmission of zoonotic diseases from cattle to dairy farm workers?
(A) Regular herd testing for brucellosis and tuberculosis disease
(B) Feeding high-protein nutritional concentrate to dairy cattle
(C) Using modern automated mechanical milking machines on farm

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(D) Maintaining low relative humidity levels in the housing barn

2018

57. Which type of milk procurement model relies strictly on private contractors acting as intermediaries between farmers and processors?
(A) The Cooperative Model
(B) The Vendor Model
(C) The Direct Farm-to-Processor Model
(D) The Integrated Corporate Model

2001

58. The Resazurin test evaluates the bacteriological quality of milk by observing a color change. What is the correct sequence of color changes as the milk quality degrades?
(A) White → Pink → Purple → Blue
(B) Blue → Lilac → Mauve → Pink → White
(C) Red → Orange → Yellow → Green
(D) Colorless → Light Blue → Dark Blue

2015

59. Which titratable acidity range (expressed as % lactic acid) is universally considered normal for fresh cow milk?
(A) 0.05 - 0.10%
(B) 0.13 - 0.17%
(C) 0.20 - 0.25%
(D) 0.25 - 0.30%

2011

60. Consider the following components relevant to clean milk production:
I. Milker's hygiene
II. Animal health and udder hygiene
III. Sanitization of milking equipment
IV. Pre-cooling of milk
V. Breed of the animal
Which of the above components represent the direct critical control points for minimizing microbial contamination during milking?
(A) I, II, III and IV
(B) II, III, IV and V
(C) I, II, IV and V
(D) I, III, IV and V

2005

61. Heavy metals such as lead and cadmium in raw milk primarily originate from which source?
(A) Veterinary drugs administered for clinical mastitis
(B) Corrosion of stainless steel milking equipment lines
(C) Chemical degradation of lactose during cold storage
(D) Contaminated feed, water, and environmental runoff

2005

62. Which legally permitted preservative is historically used in preserving milk samples destined exclusively for laboratory analytical testing?
(A) Hydrogen peroxide
(B) Sodium benzoate
(C) Potassium dichromate
(D) Sorbic acid

2004

63. Centrifugal clarifiers are distinct from cream separators primarily because clarifiers:
(A) Operate at much lower bowl rotational speeds (RPM)
(B) Have a single outlet and do not separate the fat
(C) Require raw milk to be boiled prior to system entry
(D) Separate milk into three distinct phases at once

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2011

64. Microfiltration (Bactocatch) processes typically utilize ceramic membranes with a pore size of approximately:
(A) 0.1 micrometers
(B) 1.4 micrometers
(C) 5.0 micrometers
(D) 10.0 micrometers

2012

65. Consider the following heat treatments:
I. LTLT Pasteurization
II. Thermization
III. UHT Processing
IV. In-bottle Sterilization
Which of the following represents the correct sequence in order of increasing lethality (lowest temperature/time profile to highest)?
(A) II, I, III, IV
(B) I, II, IV, III
(C) II, I, IV, III
(D) I, III, II, IV

2008

66. When evaluating homogenization efficiency under a microscope, the Farrall index requires that the majority of fat globules should not exceed what diameter?
(A) 0.5 micrometers
(B) 2.0 micrometers
(C) 5.0 micrometers

(D) 10.0 micrometers

2025

67. The F-value in thermal processing is standardized to which reference temperature?
(A) 72 degrees Celsius
(B) 100 degrees Celsius
(C) 121.1 degrees Celsius
(D) 135 degrees Celsius

2003

68. The Flow Diversion Valve (FDV) in an HTST system is triggered to divert milk when:
(A) The operating pressure inside the primary homogenizer drops.
(B) The flow rate speed of the milk feeding pump is too high.
(C) The temperature of the cooling water media suddenly rises.
(D) The milk temperature falls below the pasteurization limit.

2009

69. Which enzyme is conventionally tested to verify the adequacy of High Temperature Short Time (HTST) pasteurization?
(A) Lipoprotein lipase
(B) Alkaline phosphatase
(C) Lactoperoxidase
(D) Catalase

2005

70. Continuous sterilizers for canned or bottled milk, such as the hydrostatic sterilizer, maintain high temperatures using which medium?
(A) Circulating dry hot air currents
(B) High-intensity infrared radiation
(C) Saturated steam under high pressure
(D) Highly heated circulating boiling oil

2025

71. Indirect UHT processing is more likely to cause which sensory defect compared to direct UHT processing?
(A) Hydrolytic rancidity caused by active thermostable lipases
(B) Flat flavor defects due to excessive vacuum cooling steps
(C) Salty taste defects originating from denatured milk casein
(D) More pronounced cooked flavor from slower heating and cooling

2023

72. During the chemical sterilization of packaging material in aseptic filling machines, hydrogen peroxide is typically removed by:
(A) Drying with hot sterile air or radiation
(B) Washing with pressurized sterile water
(C) Neutralization using alkaline solutions
(D) Freezing the sterile packaging material

2011

73. Fortification of market milk with Vitamin A and D is an example of which type of public health intervention?
(A) Restoration
(B) Enrichment
(C) Standardization
(D) Pasteurization

2008

74. In the production of sterilized flavored milk, carrageenan interacts specifically with which milk protein to form a stabilizing network?
(A) Alpha-lactalbumin
(B) Kappa-casein
(C) Beta-lactoglobulin
(D) Bovine serum albumin

2011

75. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R):
Assertion (A): Whey-based beverages are increasingly popular as sports drinks.
Reason (R): Whey proteins contain high levels of branched-chain amino acids (BCAAs) which are beneficial for muscle recovery.
Which of the following is correct?
(A) Both (A) and (R) are true and (R) is the correct explanation of (A).
(B) Both (A) and (R) are true but (R) is not the correct explanation of (A).
(C) (A) is true but (R) is false.
(D) (A) is false but (R) is true.

2016

76. Goat milk is noted for its high digestibility compared to cow milk. This is primarily attributed to which compositional feature?
(A) Complete lack of lactose sugar from endogenous enzymatic breakdown
(B) Exceptionally high casein-to-whey protein ratio in the milk
(C) Smaller fat globules and more short- and medium-chain fatty acids
(D) Complete lack of alpha-s1-casein proteins in the milk profile

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2011

77. The boiling point of normal cow milk is slightly higher than that of water. What is the exact boiling point of milk at standard atmospheric pressure?
(A) 100.00 degrees Celsius
(B) 100.17 degrees Celsius
(C) 101.50 degrees Celsius
(D) 103.00 degrees Celsius

2017

78. Full cream milk, according to FSSAI standards, typically mandates a minimum fat content of:
(A) 1.5%
(B) 3.0%
(C) 4.5%
(D) 6.0%

2014

79. The Anand Pattern cooperative model ensures that profits are primarily distributed to whom?
(A) The state government departments
(B) The primary milk producer members
(C) The private external investors
(D) The international export agencies

2015

80. Consider the following statements regarding the NPDD scheme:
I. It focuses on the creation and strengthening of dairy infrastructure.
II. It provides technical and financial assistance for chilling and processing plants.
III. It completely bans the participation of private dairy enterprises.
Which of the above statement(s) is/are correct?
(A) I and II
(B) II and III
(C) I and III
(D) I, II and III

2004

81. In the context of on-farm milking practices, the 'foremilk' is often discarded to:
(A) Flush out bacteria concentrated in the teat canal
(B) Reduce the fat content of the final milk batch
(C) Decrease the overall somatic cell count of the herd
(D) Prevent the milk from churning in the bulk cooler

2023

82. Which component of a Bulk Milk Cooler (BMC) directly contacts the milk to facilitate rapid cooling?
(A) The mechanical agitator motor system
(B) The highly insulated outer steel shell
(C) The direct expansion evaporator plate
(D) The external cooling condensing unit

2007

83. The pricing of milk on a "fat-basis only" system inherently disadvantages farmers producing which type of milk?
(A) High-volume milk with lower fat levels, such as cow milk
(B) Low-volume milk containing exceptionally high fat levels
(C) Standard milk exhibiting extremely high bacterial counts
(D) Water-adulterated milk containing added solid chemicals

2017

84. The Clot on Boiling (COB) test becomes positive when the titratable acidity of milk reaches approximately what level?
(A) 0.15%
(B) 0.20%
(C) 0.24% or higher
(D) 0.50%

2015

85. Match the milk adulterant in List I with its primary purpose of addition in List II:
List I: (Adulterants)
P. Urea
Q. Starch
R. Sodium bicarbonate
S. Water
List II: (Purposes of Addition)
1. To increase specific gravity and mimic SNF
2. To artificially raise the non-protein nitrogen (SNF)
3. To increase volume and profits
4. To neutralize developed acidity
(A) P-2, Q-1, R-4, S-3
(B) P-1, Q-2, R-3, S-4
(C) P-4, Q-3, R-2, S-1
(D) P-2, Q-4, R-1, S-3

2013

86. Pesticide residues in milk are primarily lipophilic. Consequently, they tend to concentrate in which dairy product?
(A) Skim milk
(B) Whey

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(C) Butter
(D) Casein powder

2002
87. The Lactoperoxidase system catalyzes the oxidation of thiocyanate by hydrogen peroxide to produce which antimicrobial compound?
(A) Hypochlorous acid
(B) Lactic acid
(C) Peracetic acid
(D) Hypothiocyanite

2022
88. In cream separation, how does the temperature of the milk affect the efficiency of separation?
(A) Higher temperature lowers milk viscosity, increasing separation efficiency.
(B) Higher temperature raises milk viscosity, decreasing separation efficiency.
(C) Temperature variation has no biological effect on centrifugal separation.
(D) Freezing the milk solidifies the fat to ensure complete phase separation.

2002
89. Which of the following statements correctly identifies the limitations of Bactofugation?
(A) It completely eliminates 100% of all viable vegetative bacteria cells.
(B) A small fraction (2-3%) of milk volume is lost as bactofugate sludge.
(C) It causes extremely intense heat-induced denaturation of milk proteins.
(D) It can only be successfully used on milk with fat content above 6%.

2014
90. Consider the following theories of homogenization:
I. Shear theory
II. Cavitation theory
III. Micro-turbulence theory
IV. Osmotic pressure theory
Which of the above are recognized theories of fat globule disruption?
(A) I, II and III
(B) I, II and IV
(C) II, III and IV
(D) I, III and IV

2014
91. Homogenization prevents the formation of a cream line primarily by:
(A) Reducing the fat globule size and increasing density via protein adsorption
(B) Significantly increasing the physical density of the individual fat globules
(C) Chemically altering the milk triglycerides directly into simple diglycerides
(D) Destroying the native milk enzymes that are directly responsible for creaming

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2019
92. The D-value for a specific spoilage organism in milk is 2 minutes at 72 degrees Celsius. How long will it take to achieve a 3-log reduction at this temperature?
(A) 2 minutes
(B) 4 minutes
(C) 6 minutes
(D) 8 minutes

2003
93. In a modern HTST pasteurizer, the holding tube is sloped upwards slightly. What is the primary engineering reason for this?
(A) To significantly increase the internal physical turbulence of the flowing milk
(B) To facilitate much easier gravity-assisted cleaning-in-place (CIP) drainage
(C) To reduce the back pressure exerted on the main automatic flow diversion valve
(D) To ensure the pipe remains full and prevents air pockets for uniform holding

2016
94. Why is the Alkaline Phosphatase (ALP) enzyme chosen as the universal indicator for proper milk pasteurization?
(A) It is characterized as the most heat-resistant indigenous enzyme naturally found in milk.
(B) It is a foreign biochemical compound that is only present in heavily adulterated milk.
(C) Its thermal death time curve is slightly above but parallel to Mycobacterium tuberculosis.
(D) It actively assists in destroying viable bacterial spores during HTST pasteurization.

2001
95. During in-bottle sterilization, the milk often develops a brownish tint. This is primarily an outcome of:
(A) Thermal caramelization of lactose sugars alone
(B) Maillard reactions between amino acids and sugars
(C) Chemical auto-oxidation of the raw milk fat
(D) Heat-induced precipitation of calcium phosphate

2005
96. Direct steam injection (UHT process) results in the dilution of milk due to steam condensation.

How is this excess water subsequently removed to restore the original composition?
(A) By reverse osmosis filtration
(B) By ultrafiltration membranes
(C) By open vat storage evaporations
(D) By flash vacuum cooling chambers

2021

97. Which packaging format is fundamentally based on form-fill-seal technology in commercial aseptic milk packaging?
(A) Tetra Pak multi-layer cartons
(B) Glass bottles
(C) Aluminum cans
(D) Polyethylene pouches (non-aseptic)

2025

98. Recombined milk requires homogenization during its manufacture primarily to:
(A) Completely dissolve and reconstitute the spray-dried milk powder
(B) Thermally inactivate highly heat-resistant native lipase enzymes
(C) Form a stable emulsion of butter oil in the aqueous skim milk phase
(D) Artificially improve the overall white color index of the milk

2007

99. The addition of sugar to flavored milk prior to sterilization alters the processing kinetics by:
(A) Increasing heat resistance of microbial spores
(B) Decreasing the overall specific gravity of milk
(C) Decreasing the dynamic viscosity of final milk
(D) Completely preventing Maillard browning reactions

2004

100. Consider the following ingredients used in dairy beverages:
I. Whey protein concentrate
II. Probiotic bacterial cultures
III. Prebiotic dietary fibers
IV. Plant sterols
V. Artificial neutralizers
Which of the above ingredients are commonly used to formulate legitimate functional dairy beverages?
(A) I, II, III and IV
(B) II, III, IV and V
(C) I, III, IV and V
(D) I, II, IV and V

2018

101. Camel milk contains a unique biological component that makes it highly relevant for research in managing diabetes. What is this component?
(A) Significantly high levels of easily digestible lactose
(B) Insulin-like proteins resistant to stomach degradation
(C) High concentrations of conjugated linoleic acid (CLA)
(D) An exceptionally high calcium and phosphorus content

2007

102. Skimmed milk, per Codex standards, is characterized by a maximum fat content of:
(A) 0.1%
(B) 0.5%
(C) 1.5%
(D) 3.0%

2006

103. The pH of freshly drawn normal cow milk typically falls within which range?
(A) 5.5 to 6.0
(B) 6.2 to 6.4
(C) 6.5 to 6.7
(D) 7.0 to 7.4

2013

104. Which phase of Operation Flood specifically focused on consolidating the cooperative movement and expanding dairy infrastructure across all major milk sheds in India?
(A) Phase I
(B) Phase II
(C) Phase III
(D) Phase IV

2021

105. The primary mandate of the Dairy Processing and Infrastructure Development Fund (DIDF) is to:
(A) Provide subsidized high-quality fodder directly to dairy farmers
(B) Modernize dairy processing plants and machinery in cooperatives
(C) Fund advanced genetic engineering research projects in dairy cattle
(D) Eradicate pathogenetic foot-and-mouth disease on a nationwide scale

2016

106. Somatic Cell Count (SCC) in milk is an indicator of:

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(A) The nutritional quality of the cattle feed
(B) Udder health and subclinical mastitis presence
(C) The efficiency of the milking machine vacuum
(D) Adulteration with chemical synthetic milk

2009

107. In milk procurement, what is a primary limitation of the traditional "Vendor Model" compared to the "Cooperative Model"?
(A) Lack of transparency in raw milk pricing and weighing.
(B) Vendors directly process raw milk at the village level.
(C) Vendors strictly mandate the use of bulk milk coolers.
(D) The cooperative model is more prone to farm adulteration.

2022

108. Which pricing model pays farmers based on both the fat and SNF percentages, utilizing established ratios to determine total compensation?
(A) Traditional volume-based pricing
(B) Single-axis fat pricing
(C) Two-axis pricing
(D) Flat rate pricing

2010

109. An organoleptic evaluation of raw milk upon reception primarily involves assessing:
(A) The titratable acidity using sodium hydroxide
(B) The specific gravity using a lactometer
(C) The freezing point using a cryoscope
(D) The smell, taste, appearance, and temperature

2021

110. The detection of starch adulteration in milk relies on the formation of a colored complex. What color indicates a positive result?
(A) Yellow
(B) Red
(C) Blue-black
(D) Green

2018

111. Aflatoxin M_1 in milk is a metabolic byproduct of which primary mycotoxin found in contaminated cattle feed?
(A) Ochratoxin A
(B) Aflatoxin B_1
(C) Fumonisin B_1
(D) Zearalenone

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2022

112. The legally permitted level of hydrogen peroxide addition for milk preservation under the LP system guidelines in rural collection centers is extremely low. The primary purpose of this addition is to:
(A) Completely sterilize raw milk
(B) Neutralize developed lactic acid
(C) Prevent rancid lipid oxidation
(D) Activate endogenous lactoperoxidase

2016

113. In a cream separator, the skim milk exits from the periphery of the bowl while the cream exits closer to the axis of rotation. This is due to:
(A) Skim milk having a higher density than cream
(B) Skim milk having a lower density than cream
(C) Cream having a higher viscosity
(D) The higher temperature of the skim milk

2002

114. Bactofugation is most commonly applied in the dairy industry prior to the production of which specific product to prevent "late blowing"?
(A) Ultra-high temperature milk
(B) Standardized ice cream mixes
(C) Hard and semi-hard cheeses
(D) Pasteurized table butter

2015

115. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R):
Assertion (A): The second stage of a two-stage homogenizer operates at a much lower pressure (e.g., 500 psi) compared to the first stage (e.g., 2000 psi).
Reason (R): The primary purpose of the second stage is to break up the clusters of fat globules formed during the first stage, rather than disrupting individual globules.
Which of the following is correct?
(A) Both (A) and (R) are true and (R) is the correct explanation of (A).
(B) Both (A) and (R) are true but (R) is not the correct explanation of (A).
(C) (A) is true but (R) is false.
(D) (A) is false but (R) is true.

2001

116. A high Farrall index value indicates:
(A) High homogenization efficiency with highly uniform distribution of fat globules
(B) Elevated total fat content in the incoming raw milk prior to processing

(C) Poor homogenization efficiency with many large fat globules remaining
(D) Severe thermal degradation of whey proteins due to over-pasteurization

2006
117. The reference microorganism commonly used to establish the F-value for commercial sterilization of neutral pH foods (like milk) is:
(A) Clostridium botulinum
(B) Escherichia coli
(C) Bacillus stearothermophilus (Geobacillus stearothermophilus)
(D) Listeria monocytogenes

2014
118. The standard time-temperature combination for Low Temperature Long Time (LTLT) pasteurization of milk is:
(A) 63 degrees Celsius for 15 seconds
(B) 72 degrees Celsius for 30 minutes
(C) 100 degrees Celsius for 5 minutes
(D) 63 degrees Celsius for 30 minutes

2006
119. A false-positive Alkaline Phosphatase test can occasionally occur in pasteurized milk due to:
(A) Extravagant adulteration with contaminated municipal water
(B) Microbial phosphatase produced during cold storage
(C) The natural presence of colloidal casein micelles
(D) Brief exposure to high-intensity ultraviolet light

2015
120. In continuous rotary milk sterilizers, the bottles are constantly agitated during heating. What is the primary purpose of this agitation?
(A) To prevent the glass container from structural shattering
(B) To homogenize the fat and solid components within the bottle
(C) To accelerate heat transfer and prevent surface burn-on
(D) To increase the internal operational pressure of the bottle

2014
121. Scraped surface heat exchangers are essential for processing products like dairy desserts and cheese sauces because they:
(A) Utilize direct high-pressure steam injection technology
(B) Operate at much lower pressures than plate heat exchangers
(C) Eliminate the requirement for complex mechanical moving parts
(D) Continuously scrape surfaces to prevent product fouling

2011
122. Ultraviolet (UV) light is often used in combination with hydrogen peroxide for sterilizing packaging materials because UV light:
(A) Enhances the sporicidal efficacy of hydrogen peroxide
(B) Neutralizes the residual toxicity of chemical sterilants
(C) Dries the structural packaging material almost instantly
(D) Prevents the degradation and oxidation of product milk fat

2021
123. Which ingredient must be strictly omitted to classify a product as "reconstituted milk" rather than "recombined milk"?
(A) Skim milk powder or non-fat dry milk solids
(B) Anhydrous milk fat (or purified butter oil)
(C) Potable water used for reconstitution
(D) Sweet whey powder or dry whey derivatives

2015
124. The defining difference between flavored milk and a dairy drink usually lies in:
(A) The type and concentration of flavoring used
(B) The minimum required milk solid content
(C) The presence and nature of artificial colorants
(D) The specific method and temperature of pasteurization

2015
125. Match the basic physicochemical property of milk in List I with its standard approximate value for cow milk in List II:
List I: (Physicochemical Property)
P. pH
Q. Freezing Point
R. Specific Gravity
S. Boiling Point
List II: (Standard Approximate Value)
1. 1.028 - 1.032
2. -0.540 degrees Celsius
3. 6.6
4. 100.17 degrees Celsius
(A) P-3, Q-2, R-1, S-4
(B) P-2, Q-3, R-1, S-4
(C) P-3, Q-1, R-2, S-4

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(D) P-1, Q-4, R-3, S-2

2024
126. Sheep milk is highly prized for the production of specific gourmet cheeses. This is primarily because of its exceptionally high content of:
(A) Soluble lactose content
(B) Total moisture percentage
(C) Total solids content
(D) Ascorbic acid concentration

2022
127. Under standard regulatory specifications, toned milk must have a minimum fat and solids-not-fat (SNF) content of:
(A) 1.5% and 9.0%
(B) 4.5% and 8.5%
(C) 6.0% and 9.0%
(D) 3.0% and 8.5%

2015
128. The refractive index of milk is primarily influenced by which dissolved constituents?
(A) Fat globules and somatic cells
(B) Casein micelles and trapped air
(C) Lactose and dissolved minerals
(D) Bacteria and enzymes

2002
129. Operation Flood is recognized as the world's largest dairy development program. Which prominent figure is considered the "Father of the White Revolution" in India?
(A) M.S. Swaminathan
(B) Verghese Kurien
(C) Norman Borlaug
(D) C. Subramaniam

2013
130. Dairy policies often mandate the routine testing of raw milk for safety. Which of the following represents an emerging threat requiring strict regulatory monitoring in milk?
(A) Standard fluctuations in lactose concentrations
(B) Normal whey protein variations among distinct cattle
(C) Seasonal fluctuations in specific gravity parameters
(D) Antimicrobial resistance in pathogens

2012
131. The primary purpose of clipping the flanks and udders of dairy cows is to:
(A) Prevent contaminants from entering milk during harvesting
(B) Regulate the animal's body temperature in hot environments
(C) Stimulate the systemic release of milk let-down hormones
(D) Prevent the horizontal transmission of foot-and-mouth disease

NODIA

2023
132. Cold chain management in dairy procurement dictates that milk must be cooled to 4 degrees Celsius within what timeframe after milking to significantly retard bacterial growth?
(A) 2 to 4 hours
(B) 8 to 10 hours
(C) 12 to 14 hours
(D) 24 hours

2002
133. If milk is paid for solely on a volume basis without quality checks, it creates a direct economic incentive for the farmer to:
(A) Adulterate the milk with water
(B) Improve cattle genetics for higher fat yield
(C) Invest in expensive bulk milk coolers
(D) Feed high-quality concentrates

2010
134. The Methylene Blue Reduction Test (MBRT) visually assesses the reduction of the dye from blue to colorless. This chemical reduction corresponds to a shift in which physical parameter of the milk?
(A) pH level and total acidity
(B) Specific gravity at standard temperature
(C) Surface tension of the liquid phase
(D) Oxidation-reduction (redox) potential

2002
135. Identify the correct sequence of steps for conducting the Gerber test to determine milk fat.
(A) Add milk → Add sulfuric acid → Add amyl alcohol → Centrifuge → Read fat percentage
(B) Add sulfuric acid → Add milk → Add amyl alcohol → Centrifuge → Read fat percentage
(C) Add amyl alcohol → Add milk → Add sulfuric acid → Centrifuge → Read fat percentage
(D) Add milk → Add amyl alcohol → Add sulfuric acid → Centrifuge → Read fat percentage

2014
136. Detergents are added to synthetic milk primarily to act as:
(A) Preservatives to prevent bacterial growth

(B) Sweetening agents to enhance overall flavor
(C) Emulsifiers to suspend vegetable fat
(D) Colorants to closely mimic natural milk

2016

137. Which of the following analytical techniques is considered the "gold standard" for the precise quantification of heavy metals in milk?
(A) High-Performance Liquid Chromatography
(B) Fourier Transform Infrared Spectroscopy
(C) Gerber Centrifugation and fat separation
(D) Inductively Coupled Plasma Mass Spectrometry

2007

138. The addition of legally permitted preservatives in milk is generally prohibited for retail fluid milk. However, specific regulatory exceptions exist for:
(A) Raw milk preservation in areas lacking cold chain systems
(B) Masking the sour taste of thermally damaged or spoiled milk
(C) Enhancing the overall flavor profile of processed UHT milk
(D) Standardizing the fat and solids-not-fat content in cream

2011

139. In a cream separator, the closely spaced conical discs serve what fluid mechanical purpose?
(A) They increase the temperature of milk through friction and shear forces.
(B) They divide milk into thin layers to reduce fat settling distance.
(C) They homogenize the fat globules by utilizing extreme mechanical force.
(D) They filter out large particulate matter such as hair, dust, and straw.

2010

140. Microfiltration of skim milk (Bactocatch process) utilizes a specific trans-membrane pressure profile. The purpose of maintaining a uniform trans-membrane pressure is to:
(A) Maximize the denaturation of major whey protein fractions
(B) Prevent rapid membrane fouling by casein micelles
(C) Ensure all fat globules are forced through the physical pores
(D) Sterilize the incoming liquid milk via high hydraulic pressure

2007

141. Single-stage homogenization is generally adequate for which type of dairy product?
(A) Low-fat or highly viscous products
(B) High-fat cream products with over thirty percent fat
(C) Standard commercial ice cream formulation mixes
(D) Concentrated or double-strength evaporated milk

2022

142. Homogenization of raw milk without subsequent pasteurization leads to rapid development of rancidity. This is because:
(A) Homogenization introduces large amounts of dissolved atmospheric oxygen.
(B) Homogenization directly denatures whey proteins, producing off-flavors.
(C) Disrupting the globule membrane exposes fat to native lipase.
(D) Cavitation forces chemically break down short-chain volatile fatty acids.

2019

143. Thermal death time configurations rely heavily on the assumption that microbial destruction follows which type of kinetics?
(A) Standard zero-order kinetics
(B) Complex second-order kinetics
(C) Saturated Michaelis-Menten kinetics
(D) First-order kinetics

2007

144. In a Plate Heat Exchanger used for pasteurization, turbulent flow is strictly maintained to:
(A) Prevent the milk fat from churning and forming butter granules
(B) Reduce the electrical power consumption of the product milk pump
(C) Maximize heat transfer efficiency and prevent boundary buildup
(D) Facilitate the mechanical separation of cream from the skim phase

2015

145. Arrange the following steps in the sequence they occur during commercial aseptic packaging of ultra-high temperature (UHT) milk:
I. Sterilization of the packaging material
II. Formation of a sterile environment in the filling zone
III. Filling of sterile milk into the packaging
IV. Hermetic sealing of the package
(A) II, I, III, IV
(B) I, II, III, IV

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(C) II, III, I, IV
(D) I, III, II, IV

2023
146. A critical post-pasteurization safety check involves testing for coliform bacteria. The presence of coliforms in pasteurized milk definitively indicates:
(A) The raw milk originated from clinically diseased dairy cows.
(B) The thermal pasteurization holding time was excessively long.
(C) The mechanical homogenizer operating pressure was insufficient.
(D) Post-pasteurization contamination of the final product.

2007
147. Whey protein denaturation during high-heat treatment (like sterilization) primarily involves which specific protein fraction interacting with kappa-casein?
(A) Beta-lactoglobulin
(B) Alpha-lactalbumin
(C) Bovine serum albumin
(D) Immunoglobulins

2025
148. The primary limitation of using direct steam injection for UHT processing is that:
(A) It causes excessive thermal damage compared to indirect heating systems.
(B) It cannot process standard liquid milk, but only highly viscous purees.
(C) It requires culinary-grade, chemical-free steam.
(D) It takes several minutes to reach the target sterilization temperatures.

2011
149. Reconstituted milk is frequently manufactured in regions facing which specific challenge?
(A) Deficit in local raw milk production
(B) High prevalence of lactose intolerance in populations
(C) Explicit surplus of fresh cream
(D) Strict bans on importing milk powders

2009
150. Which vitamin is highly sensitive to light and often degrades rapidly in milk stored in transparent glass or plastic bottles?
(A) Ascorbic acid
(B) Cholecalciferol
(C) Thiamine
(D) Riboflavin

2010
151. Functional dairy beverages containing plant sterols are primarily marketed for their ability to:
(A) Improve lactose digestion in sensitive individuals
(B) Lower serum cholesterol levels
(C) Enhance athletic endurance during physical exercises
(D) Provide high-density calories for active lifestyles

2004
152. The characteristic white appearance of milk is primarily an optical effect caused by the scattering of light by:
(A) Dissolved lactose and minerals in the aqueous phase
(B) Riboflavin pigments and carotene compounds
(C) Fat globules and casein micelles
(D) Whey protein fractions and water molecules

2005
153. According to standard dairy specifications, what is the expected fat content of pure, unadulterated buffalo milk?
(A) 3.0 to 4.0%
(B) 4.5 to 5.5%
(C) 6.0 to 8.0%
(D) 9.0 to 11.0%

NODIA

2010
154. The specific gravity of milk is determined by which of the following primary factors?
(A) The concentration of dissolved gases only
(B) The somatic cell count and microbial load
(C) The temperature of measurement and the concentrations of fat and SNF
(D) The atmospheric pressure during measurement

2003
155. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R):
Assertion (A): The Anand Pattern cooperative structure eliminates middlemen from the milk supply chain.
Reason (R): Village-level societies procure milk directly from producers, and district unions process and market the products.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.

(D) A is false but R is true.

2012

156. The National Programme for Dairy Development (NPDD) provides special financial incentives for establishing dairy infrastructure in which specific regions of India?
(A) Metropolitan cities exclusively across the country
(B) Hilly and backward districts
(C) Arid and semi-arid desert regions only
(D) Special Economic Zones (SEZs) near ports

2017

157. Which bacteria are commonly associated with poor hygienic milking practices and environmental contamination from manure?
(A) Coliforms
(B) Lactic acid bacteria
(C) Propionibacterium
(D) Bifidobacterium

2010

158. An insulated milk tanker utilizes which thermal transport principle to minimize heat gain during transit?
(A) Active vapor-compression mechanical refrigeration systems
(B) Convective heat transfer optimization through design
(C) Polyurethane foam insulation
(D) Evaporative cooling methods applied on the outer shell

2017

159. In the context of milk payment, what is a "quality premium"?
(A) A financial penalty imposed on farmers for high bacterial counts
(B) A transport-related deduction made for operational hauling costs
(C) A standard flat rate paid on equal volume to all cooperative members
(D) An additional payment for exceeding standard parameters

2018

160. The Titratable Acidity (TA) test uses Phenolphthalein as an indicator. The endpoint of the titration is marked by the appearance of which color?
(A) Deep crimson
(B) Yellow
(C) Faint pink
(D) Blue

2023

161. Adulteration of milk with cane sugar (sucrose) is primarily done to:
(A) Increase the fat content to simulate rich buffalo milk quality
(B) Restore specific gravity and solids-not-fat (SNF) after water dilution
(C) Preserve the milk from bacterial spoilage during hot weather
(D) Alter the pH of the milk to mimic fresher dairy products

2025

162. The presence of antibiotic residues in milk poses a direct public health concern primarily because it can:
(A) Decrease the nutritional value of milk proteins during thermal processing
(B) Accelerate the souring of pasteurized milk products during cold storage
(C) Increase the risk of heavy metal poisoning through chemical pathways
(D) Cause allergic reactions and promote antimicrobial resistance

2011

163. Thermization is generally carried out at which temperature-time combination?
(A) 63 to 65 degrees Celsius for 15 seconds
(B) 72 to 75 degrees Celsius for 15 seconds
(C) 135 to 140 degrees Celsius for 2 seconds
(D) 85 to 90 degrees Celsius for 30 minutes

2002

164. In centrifugal clarification, the solid impurities that accumulate on the bowl wall are commonly referred to as:
(A) Clarifier cream
(B) Bactofugate
(C) Separator slime
(D) Milk stone

2007

165. Match the processing equipment or method in List I with its primary mode of action in List II:
List I: (Equipment or Method)
P. Tubular Heat Exchanger
Q. Direct Steam Injection
R. Homogenizing Valve
S. Centrifugal Separator
List II: (Mode of Action)
1. Intense shear and cavitation forces
2. Density difference in a high-G field
3. Convective heat transfer across a stainless steel barrier
4. Latent heat of condensation transferred

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directly into the product
(A) P-3, Q-4, R-1, S-2
(B) P-4, Q-3, R-2, S-1
(C) P-1, Q-2, R-3, S-4
(D) P-3, Q-1, R-4, S-2

2015
166. A critical factor in assessing homogenization efficiency is the tendency of fat globules to cluster after passing through the valve. Clustering is heavily dependent on the ratio of:
(A) Lactose to water
(B) Whey protein to calcium
(C) Somatic cells to bacteria
(D) Fat to casein

2011
167. If the thermal death time (F-value) is given as $F_0 = 3$, this means the sterilization process delivers a lethality equivalent to:
(A) 3 seconds at 135.0 degrees Celsius temperature
(B) 3 minutes at 121.1 degrees Celsius
(C) 3 hours at 100.0 degrees Celsius temperature
(D) 3 logs of total bacterial population reduction

2024
168. Which component in an HTST pasteurizer ensures that unpasteurized milk and pasteurized milk cannot physically mix, even if a pinhole leak develops in a plate?
(A) The flow diversion valve directing under-heated milk
(B) The raw milk balance tank stabilizing intake flow
(C) Positive pressure on the pasteurized side
(D) The holding tube ensuring standard retention times

2003
169. What is the fundamental difference between LTLT and HTST pasteurization regarding their impact on milk quality?
(A) LTLT destroys bacterial spores, whereas standard HTST does not
(B) LTLT causes complete denaturation, while HTST causes zero change
(C) HTST is exclusively a batch process, while LTLT is continuous
(D) HTST results in less thermal damage than LTLT

2002
170. Continuous in-container sterilization of milk requires careful headspace control in the bottle. Why is a headspace necessary?
(A) To accommodate thermal expansion during heating
(B) To allow space for adding artificial flavorings after sterilization
(C) To trap residual aerobic bacteria inside the sealed container
(D) To increase the oxidation rate of unstable milk fat molecules

2010
171. A major advantage of indirect UHT heating systems over direct systems is:
(A) They produce less cooked or caramelized flavor in milk
(B) They offer high energy recovery efficiencies
(C) They completely eliminate the need for a homogenizer
(D) They are completely immune to protein fouling on plates

2022
172. In commercial aseptic filling operations, why is a positive pressure of sterile air maintained inside the filling chamber?
(A) To force the liquid milk out of the filling nozzles much faster
(B) To prevent the ingress of unsterile ambient air
(C) To dry the wet sterilizing packaging material inside the zone
(D) To continuously aerate the processed milk prior to final sealing

2001
173. When formulating recombined milk, what is the optimal temperature for rehydrating skim milk powder to ensure maximum solubility and minimal lump formation?
(A) 4 to 10 degrees Celsius
(B) 40 to 50 degrees Celsius
(C) 80 to 90 degrees Celsius
(D) Over 100 degrees Celsius

2010
174. Which process must be tightly controlled when manufacturing flavored milk with cocoa powder to prevent a bitter astringent taste and visual defects?
(A) Thorough deaeration of the liquid mix
(B) Complete removal of all milk fat components
(C) Suspension of cocoa using hydrocolloids
(D) Controlled fermentation with starter bacteria

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2015
175. Whey-based beverages typically exhibit a pH in which range, contributing to their refreshing, slightly tart flavor?
(A) 3.5 to 4.5
(B) 6.5 to 7.0
(C) 7.5 to 8.5
(D) 9.0 to 10.0

2006
176. Which minor dairy species provides milk that naturally lacks the agglutinin protein, meaning its cream does not readily rise to the top upon standing?
(A) Buffalo
(B) Cow
(C) Goat
(D) Sheep

2023
177. According to standard regulatory specifications, the term "milk" without any prefix designates the normal mammary secretion of:
(A) Exclusively cows of foreign or indigenous breeds
(B) Cows or buffaloes, or a mixture thereof
(C) Exclusively buffaloes from certified dairy farms
(D) Any milking mammal, including camels and goats

2021
178. What is the standard refractive index of normal cow milk measured at 20 degrees Celsius?
(A) 1.3320 to 1.3340
(B) 1.3440 to 1.3480
(C) 1.3500 to 1.3550
(D) 1.4000 to 1.4200

2004
179. The success of the Anand Pattern is largely credited to linking rural milk producers directly with:
(A) Urban consumers via direct marketing channels
(B) Highly competitive international export markets
(C) Private multinational corporate dairy processors
(D) State-funded local agricultural universities

2005
180. The National Dairy Plan (NDP), an allied scheme in India, primarily focused on increasing milk production through:
(A) Importing heavily subsidized foreign milk powder
(B) Strict rationing of milk consumption in urban areas
(C) Scientific breeding and superior feeding
(D) Banning the commercial slaughter of all livestock

2023
181. What is the most common chemical compound utilized for sanitizing milking machine clusters between cows to prevent cross-contamination?
(A) Dilute sodium hypochlorite
(B) Standard formaldehyde solution
(C) Concentrated sulfuric acid
(D) Aqueous sodium hydroxide

2017
182. Bulk Milk Coolers are typically graded by their cooling capacity, measured in:
(A) Total volume of liquid milk handled in liters per hour
(B) Total structural mass in kilograms per square meter
(C) Maximum operational homogenizing pressure of the pump
(D) Milking sessions they can cool in a given time

2006
183. In the Richmond formula, $TS = \frac{CLR}{4} + (1.2 \times F) + 0.14$, what does CLR stand for?
(A) Calculated Lactose Ratio Value
(B) Corrected Lactometer Reading
(C) Combined Lipid Recovery Rate
(D) Coagulated Lactic Residue Test

NODIA

2013
184. The organoleptic evaluation of milk is most sensitive to identifying which common raw milk defect?
(A) Minor fluctuations in SNF
(B) The exact concentration of Aflatoxin M_1
(C) Feed flavors, rancidity, and sourness
(D) The specific bacterial species present

2008
185. A positive result in the Baudouin test indicates the adulteration of milk fat (ghee/butter) with:
(A) Hydrocarbon-based mineral oil
(B) Rendered animal tallow derivatives
(C) Purified corn or potato starch
(D) Vanaspati fat with sesame oil

2011
186. Which category of pesticide residues is most persistent in the dairy environment and consequently monitored rigorously in milk?
(A) Organochlorines
(B) Organophosphates
(C) Carbamates
(D) Pyrethroids

2013
187. The Lactoperoxidase system is most effective in extending the shelf life of raw milk when activated at which temperature?
(A) Standard refrigeration at 4 degrees Celsius
(B) Ambient temperatures
(C) HTST pasteurization at 72 degrees Celsius
(D) Standard boiling point at 100 degrees Celsius

2015
188. Centrifugal clarifiers are highly effective at removing somatic cells from milk. High somatic cell counts in milk typically indicate:
(A) Adulteration with detergent
(B) Mastitis infection in the herd
(C) Excessive homogenization
(D) Spoilage by lactic acid bacteria

2023
189. Microfiltration of milk specifically targets the physical removal of:
(A) Bacteria and endospores
(B) Dissolved lactose molecules
(C) Soluble whey proteins
(D) Dissolved mineral salts

2001
190. Cavitation, a primary force in homogenization, occurs when the static pressure in the homogenizing valve:
(A) Exceeds the mechanical tensile strength of the native fat membrane
(B) Causes the temperature of the milk to exceed hundred degrees Celsius
(C) Drops below the fluid's vapor pressure, forming collapsing bubbles
(D) Induces microscopic ice crystal formation inside the valve assembly

2023
191. The efficiency of a homogenizer decreases significantly if:
(A) The milk is fully pasteurized prior to homogenization
(B) The valves are made of tungsten carbide
(C) The fat content of the milk is below one percent
(D) Air is entrained in milk entering the pump

2019
192. During the calculation of the F-value, the standard Z-value for the destruction of Clostridium botulinum spores is generally accepted as:
(A) 5 degrees Celsius
(B) 10 degrees Celsius
(C) 15 degrees Celsius
(D) 20 degrees Celsius

2022
193. In a typical HTST setup, what follows immediately after the holding tube?
(A) The balance tank
(B) The flow diversion valve
(C) The regenerator heating section
(D) The packaging machine

2005
194. Which test is used to detect the re-contamination of pasteurized milk by raw milk due to a leaky regenerator section?
(A) Gerber test
(B) Clot on Boiling test
(C) Freezing point test
(D) Phosphatase test

2005
195. In-bottle sterilization provides excellent microbial stability but is often criticized for its negative impact on:
(A) Nutritional profile and sensory qualities
(B) Structural integrity of the packaging material
(C) Homogenization stability of milk fat globules
(D) Skimming efficiency of centrifugal separators

2007
196. Direct steam infusion differs from direct steam injection in that infusion involves:
(A) Injecting high-pressure steam into a narrow pipe of flowing milk
(B) Passing product milk through a steam-heated indirect tubular coil
(C) Spraying milk into a chamber filled with steam
(D) Directly adding hydrogen peroxide to the incoming raw milk

2009
197. Which packaging material layer in an aseptic carton provides an absolute barrier to oxygen and light?
(A) Aluminum foil layer
(B) Polyethylene coating

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(C) Paperboard structure
(D) Polyamide composite

2021
198. The term "standardized milk" generally implies that the milk has been adjusted to meet specific regulatory criteria for:
(A) Vitamin content only
(B) Titratable acidity and pH
(C) Bacterial counts only
(D) Fat and SNF content

2013
199. Stabilizers used in flavored milk, such as sodium alginate, function primarily by:
(A) Sweetening the product without adding extra dietary calories
(B) Increasing viscosity to retard particle settling
(C) Bleaching the natural yellow-white color of raw milk
(D) Acting as an active chemical preservative against molds

2013
200. Bio-active fortified liquid milks may incorporate lactoferrin as an active ingredient. Lactoferrin is prized for its:
(A) Intense sweetening power
(B) Ability to drastically lower the freezing point of milk
(C) Antimicrobial and immunomodulatory properties
(D) Coloring properties

2023
201. Which minor dairy species yields milk known for containing a significantly higher concentration of lysozyme, contributing to superior natural keeping quality?
(A) Buffalo
(B) Sheep
(C) Goat
(D) Camel

2007
202. Standard regulatory specifications state that raw milk meant for direct human consumption or processing must be obtained from animals that are:
(A) Healthy and free from transmissible diseases
(B) Fed exclusively on certified outdoor pastures
(C) Of a specific exotic or highly pure breed pedigree
(D) Milked purely by automatic robotic milking machines

2019
203. The specific gravity of milk decreases when:
(A) Water is added or the fat content is increased
(B) Soluble minerals are added to the milk
(C) Skim milk is added to the milk
(D) The milk is cooled from 20 to 4 degrees Celsius

2019
204. By global ranking, India's contribution to total world milk production is approximately:
(A) 5%
(B) 12%
(C) 24%
(D) 45%

NODIA

2002
205. Dairy cooperatives under the Anand Pattern issue a passbook to farmer members primarily to record:
(A) Volume, fat, SNF, and daily payment value
(B) Routine cattle vaccination and healthcare dates
(C) Financial subsidies received for cattle sheds
(D) Authorized veterinary drug prescription history

2004
206. A key farm practice to minimize the risk of Aflatoxin M_1 in milk is:
(A) Pasteurizing raw milk at excessively high temperatures
(B) Administering synthetic antifungal medications monthly
(C) Feeding cattle mold-free grains and silage
(D) Homogenizing raw milk immediately following milking

2002
207. Which component is strictly prohibited from being transported in a bulk milk insulated tanker due to severe safety and quality risks?
(A) Bulk volume of chilled raw milk
(B) Pasteurized standardized liquid milk
(C) Raw high-fat cream intermediates
(D) Adulterated or non-food liquids

2018
208. The two-axis pricing policy aims to ensure fairness by:
(A) Paying equally for water and total solids components
(B) Paying higher rates in summer and lower rates in winter
(C) Valuing fat and SNF independently
(D) Paying based on distance of the farm from

the dairy

2015
209. If a raw milk sample fails the alcohol test (shows coagulation), the most probable cause is:
(A) Severe adulteration with industrial cane sugar
(B) High acidity or abnormal mineral balance
(C) Extremely low fat content from skimmed milk
(D) Active presence of added chemical neutralizers

2024
210. The Rosalic acid test detects the presence of neutralizers. A positive result is indicated by a color change to:
(A) Bright yellow
(B) Forest green
(C) Dark brown
(D) Rose red

2024
211. Heavy metal contamination in milk is most effectively mitigated by:
(A) Strict environmental and feed controls
(B) Boiling the milk extensively at home
(C) Utilizing commercial centrifugal clarification
(D) Adding approved chelating agents to raw milk

2016
212. Why is thermization preferred over pasteurization for raw milk intended for certain types of raw milk cheese production?
(A) It achieves commercial sterility while maintaining raw milk flavor
(B) It causes maximum whey protein denaturation for better curd firmness
(C) It kills psychrotrophs while preserving native enzymes
(D) It completely eliminates the subsequent need for any starter cultures

2002
213. In centrifugal separation, increasing the rotational speed (RPM) of the bowl will generally:
(A) Increase the efficiency of skimming
(B) Decrease the skimming efficiency significantly
(C) Cause the milk fat to oxidize and turn rancid
(D) Have no real effect on the skimming efficiency

2010
214. Bactofugation utilizes special centrifuges equipped with mechanisms to continuously or intermittently discharge:
(A) Concentated pure cream
(B) Extracted purified water
(C) Insoluble lactose crystals
(D) Spore-rich sludge

2001
215. Age gelation of UHT-sterilized milk during storage is a major physical defect primarily caused by:
(A) The growth of heat-resistant spore-forming thermophiles
(B) Retrogradation of gelatinized starch added as stabilizer
(C) Slow enzymatic proteolysis of casein micelles by residual bacterial proteases
(D) Oxidative polymerization of unsaturated fatty acids in the fat membrane

2023
216. The Clot-on-Boiling (COB) test is a rapid platform test used to assess the heat stability of raw milk. Milk will generally fail this test (show visible coagulation) when its developed acidity reaches or exceeds approximately what level (expressed as % lactic acid)?
(A) 0.08% to 0.10%
(B) 0.11% to 0.13%
(C) 0.15% to 0.17%
(D) 0.21% to 0.23%

2009
217. A thermal death time curve plotted on a semi-logarithmic graph displays:
(A) Bacterial concentration versus time
(B) Temperature versus pressure
(C) Enzyme concentration versus pH
(D) Log of D-value versus temperature

2018
218. In an HTST pasteurizer, the cooling section utilizes which utility to rapidly chill the pasteurized milk to 4 degrees Celsius?
(A) Chilled water or glycol
(B) Circulated ambient air
(C) Cryogenic liquid nitrogen
(D) High-pressure utility steam

2025
219. The Alkaline Phosphatase test for pasteurized milk utilizes a substrate that the native ALP enzyme cleaves to produce a colored compound. The most common substrate used is:
(A) Lactose monohydrate
(B) p-Nitrophenyl phosphate
(C) Hydrogen peroxide solution
(D) Resazurin sodium salt

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2001

220. The primary cause of whey protein denaturation during heat processing is the unfolding of the protein structures due to the breakage of:
(A) Covalent peptide bonds
(B) Disulfide and hydrogen bonds
(C) Intermolecular glycosidic linkages
(D) Strong hydrophobic ester bonds

2010

221. An aseptic UHT plant is experiencing frequent burn-on (fouling) in the tubular heat exchangers. Which operational parameter adjustment might best mitigate this?
(A) Pre-holding at 90 degrees Celsius to stabilize proteins
(B) Increasing the temperature difference of the heating medium
(C) Reducing the product fluid velocity inside the tubes
(D) Adding a strong food-grade mineral acid to the milk

2002

222. The sterilization of aseptic packaging materials using hydrogen peroxide is most effective when the concentration of the H_2O_2 bath is maintained around:
(A) 5%
(B) 10%
(C) 30% to 35%
(D) 70%

2019

223. What specific ingredient defect commonly leads to poor flavor in recombined milk?
(A) Improperly ultra-filtered water
(B) High-heat non-fat dry milk powder
(C) Insufficiently soluble lactose sugar
(D) Oxidized anhydrous milk fat

2014

224. Sterilized flavored milk beverages packaged in glass bottles most commonly undergo heat treatment inside a:
(A) Plate heat exchanger system
(B) Tubular heat exchanger system
(C) Rotary retort sterilizer
(D) Direct steam injector system

2017

225. A dairy beverage heavily fortified with live Bifidobacterium species is classified under which functional food category?
(A) Prebiotic beverage
(B) Probiotic beverage
(C) Isotonic beverage
(D) Hypoallergenic beverage

2017

226. According to standard international definitions, a product can only be labeled as "Milk" if it is:
(A) Derived purely from plants such as almond, soy, or oat
(B) An artificial emulsion of vegetable oil in sweet whey
(C) A fermented soy beverage fortified with minerals
(D) Mammary secretion without any addition or extraction

NODIA

2006

227. The freezing point of normal milk is a highly constant physiological parameter primarily determined by the concentration of:
(A) Lactose and chlorides
(B) Insoluble casein and fat
(C) Native vitamins and enzymes
(D) Somatic cell concentration

2005

228. The Operation Flood program was primarily funded initially by:
(A) Direct taxation levied on all urban Indian citizens
(B) Commercial loans secured from private banking systems
(C) The sale of gifted skimmed milk powder and butter oil
(D) High export tariffs imposed on agricultural goods

2022

229. Which of the following best describes the principle of "Clean Milk Production" at the farm level?
(A) End-to-end sanitary practices from cow to cooling
(B) Using heavy chemical preservatives to mask poor hygiene on farms
(C) Filtering the milk multiple times through a clean cloth filter
(D) Boiling the raw milk immediately upon extraction from the cow

2018

230. In evaluating raw milk quality, a high titratable acidity (e.g., 0.19% lactic acid) immediately upon reception most likely indicates:
(A) Exceptional freshness of milk directly from the udder
(B) Natural physiological variation due to dairy

breed types

(C) Excessive mechanical homogenization pressure at the plant

(D) Bacterial lactic acid production during poor storage

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ANSWERS

1. (A) Average fat (4%), lactose (4.8%), and protein (3.3%)
Normal bovine milk typically contains approximately four percent fat, four point eight percent lactose, and three point three percent protein, alongside water and minor constituents. These components represent the standard macro-compositional profile of healthy dairy cattle secretions globally, serving as the benchmark for quality assessment, legal standardization, and industrial dairy formulation processes.

2. (C) 4.5% fat and 8.5% SNF
Regulatory authorities in India mandate that standardized milk must contain a minimum of four point five percent milk fat and eight point five percent solids-not-fat. This legal specification ensures nutritional consistency, prevents fraudulent dilution, and provides a uniform product standard for consumer protection and fair pricing throughout the commercial dairy market.

3. (B) 1.028 to 1.032
The normal physical density of fresh bovine milk relative to water at fifteen point six degrees Celsius ranges between one point zero two eight and one point zero three two. This specific gravity is influenced by the concentration of dissolved and suspended constituents like proteins, lactose, minerals, and milk fat, serving as a rapid indicator of purity.

4. (D) National Dairy Development Board
The massive national dairy expansion initiative known as Operation Flood was strategically planned and implemented by the National Dairy Development Board. Founded to replicate the successful cooperative model nationwide, the organization established a robust network linking rural milk producers directly with urban consumers, thereby transforming India into a self-sufficient, leading global milk producer.

5. (B) Enhance the quality of milk and create dairy infrastructure
The National Programme for Dairy Development focuses on strengthening the cold chain infrastructure and improving milk quality at the grassroots level. By financing clean milk production systems, establishing village-level chilling units, and training farmers, the scheme aims to increase the market share of organized cooperatives and ensure safe dairy products for consumers.

6. (C) Post-milking teat dipping with an approved sanitizer
Applying a germicidal dip to cow teats immediately after milking is highly effective in preventing environmental mastitis. The teat canal remains dilated for some time after extraction, and sanitizing the surface forms a protective barrier that kills pathogens, thereby preventing bacterial entry and significantly reducing microbial contamination of the raw milk.

7. (D) To rapidly chill raw milk to 4 degrees Celsius
Bulk milk coolers are designed to rapidly lower the temperature of freshly drawn raw milk to four degrees Celsius at village collection centers. This rapid chilling halts the growth of thermophilic and mesophilic bacteria, preserving the chemical and microbiological quality of the milk during storage and prior to transport.

8. (A) Fat and solids-not-fat (SNF) content
The two-axis pricing system determines the monetary value of milk based on both fat and solids-not-fat percentages. This approach ensures fair compensation for farmers by recognizing the economic value of all milk solids, preventing the bias associated with older fat-only methods and discouraging the practice of skimming or watering down milk.

9. (B) Clot on Boiling (COB) Test
The clot on boiling test is a rapid platform method used to evaluate the thermal stability of incoming raw milk. An increase in acidity, caused by bacterial fermentation, destabilizes milk proteins, making them susceptible to coagulation upon heating. Milk that clots during this test is deemed unfit for high-temperature processing.

NODIA

10. (A) I and II
Synthetic milk is an artificial chemical emulsion made by blending urea, detergents, vegetable oils, and sodium sulfate to mimic the appearance of natural milk. While urea is added to falsely elevate the non-protein nitrogen and solids-not-fat values, this highly toxic mixture lacks the complex biological whey proteins naturally present in bovine secretions.

11. (A) Enzyme-Linked Immunosorbent Assay (ELISA)
The enzyme-linked immunosorbent assay is widely utilized in the dairy industry for the rapid, highly sensitive detection of toxic aflatoxin residues in raw milk. This immunological method relies on specific antigen-antibody binding reactions, allowing quality control laboratories to quickly screen incoming milk consignments and reject contaminated batches before processing.

12. (C) Hydrogen peroxide and sodium thiocyanate
Activating the natural lactoperoxidase preservation system in raw milk requires the balanced addition of trace amounts of hydrogen peroxide and sodium thiocyanate. These chemicals react with the native lactoperoxidase enzyme to produce hypothiocyanite, a potent, short-lived antimicrobial compound that temporarily inhibits bacterial replication under ambient storage conditions.

13. (D) The square of the fat globule radius
According to Stokes' Law, the terminal rising velocity of a fat globule suspended in liquid milk is directly proportional to the square of its radius. This mathematical relationship explains why larger fat globules cream much faster than smaller ones under gravity, and underlies the mechanical separation process where centrifugal force enhances this velocity.

14. (C) Removal of bacterial spores using high-speed centrifugation
Bactofugation is a specialized physical separation process that uses high-speed centrifugal force to remove heavy micro-organisms, particularly heat-resistant bacterial spores, from milk. Because spores have a higher density than the surrounding liquid phase, they are forced to the periphery of the rotor, enabling effective mechanical purification without thermal damage.

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15. (C) (A) is true but (R) is false.
Two-stage homogenization is indeed preferred for high-fat dairy products because the first stage breaks down the fat globules, while the second stage disperses the clusters of globules that tend to reform. However, the primary cavitation and shear forces are generated in the first stage, whereas the second stage uses much lower pressure.

16. (D) The Farrall index
The efficiency of the milk homogenization process is quantitatively evaluated using the Farrall index. This analytical method involves examining the treated milk under a microscope to measure the size distribution of fat globules, ensuring that the vast majority are reduced below two micrometers in diameter to prevent gravity separation and creaming during storage.

17. (A) The time required to reduce a microbial population by 90% at a constant temperature
In thermal death kinetics, the decimal reduction time, or D-value, represents the heating duration in minutes needed to destroy ninety percent of a specific microbial population at a defined temperature. This value is critical for calculating pasteurization and sterilization processes, ensuring sufficient logarithmic reduction of pathogens and spoilage organisms.

18. (B) 72 degrees Celsius for 15 seconds
High temperature short time pasteurization is a continuous flow thermal process legally requiring milk to be heated to at least seventy-two degrees Celsius and held for fifteen seconds. This precise combination is scientifically proven to destroy all vegetative pathogens, particularly Coxiella burnetii, while minimizing thermal damage to milk flavor and nutritional value.

19. (A) Inadequate pasteurization or post-processing contamination
A positive alkaline phosphatase test in pasteurized milk indicates that the heating process was insufficient or that raw milk contaminated the pasteurized product. Since this natural milk enzyme is slightly more heat-resistant than common vegetative pathogens, its active presence serves as a sensitive, reliable indicator of major thermal processing failures.

20. (B) II, III and IV
In-bottle sterilization is a batch or continuous thermal treatment of packaged milk operating at high temperatures for extended periods. This severe heating profile causes extensive denaturation of whey proteins and promotes Maillard browning reactions between lactose and lysine, which imparts a highly characteristic caramelized, cooked flavor and brown color to the product.

21. (B) Uperization
Uperization is a direct ultra-high temperature processing method in which culinary steam is injected directly into pressurized milk. This contact results in rapid heating to temperatures around one hundred and forty degrees Celsius. The added water is subsequently removed by flash evaporation, minimizing the thermal holding time and reducing chemical browning.

22. (C) Hydrogen peroxide
Hydrogen peroxide is the standard chemical sterilant utilized in commercial aseptic packaging machines to treat paperboard and plastic film. The packaging material is bathed in or sprayed with a concentrated solution, which is then evaporated using hot sterile air to ensure the complete destruction of bacterial spores before aseptic filling.

23. (D) Recombined milk uses butter oil and skim powder, while reconstituted uses whole milk powder.
Recombined milk is manufactured by dispersing skim milk powder and anhydrous milk fat or butter oil in water to match normal milk composition. In contrast, reconstituted milk is produced by dissolving whole milk powder alone in water, restoring the milk to its original fluid state without requiring the addition of separate fat components.

24. (A) Carrageenan
Carrageenan is a naturally derived seaweed hydrocolloid added to chocolate-flavored milk. It forms a weak helical gel network by interacting directly with positively charged regions of kappa-casein micelles. This specialized structural network increases the viscosity of the fluid just enough to keep heavy cocoa particles suspended, preventing unattractive sedimentation.

25. (A) P-3, Q-1, R-2, S-4
Acidophilus milk is a probiotic dairy beverage fermented using Lactobacillus acidophilus. Rivella is a carbonated Swiss beverage formulated with milk whey. Kefir is produced through a complex symbiotic fermentation using yeast and bacterial grains. Toned milk is a standardized product containing three percent fat and eight point five percent solids-not-fat.

26. (B) Camel
Camel milk is biologically unique and contains three to five times higher average concentrations of ascorbic acid, or Vitamin C, compared to bovine milk. This high antioxidant level is vital for the survival of offspring in arid desert environments and provides consumers with an excellent dietary source of this essential micronutrient.

27. (C) 0.18%
International standards specify that the maximum permissible limit for natural, developed titratable acidity in fresh cow milk is zero point eighteen percent, calculated as lactic acid. Any values exceeding this threshold indicate bacterial fermentation of lactose, suggesting poor hygiene, inadequate cold chain storage, or advanced microbial spoilage of the milk.

28. (C) Freezing point depression
Freezing point depression is the most precise colligative property used to detect extraneous water in milk. Because milk contains constant amounts of dissolved lactose and salts, its freezing point remains highly stable. The addition of water dilutes these soluble constituents, raising the freezing point closer to zero degrees Celsius.

29. (D) District Milk Producers' Unions
The cooperative Anand Pattern is organized into a three-tier system to streamline milk procurement and processing. The middle tier consists of District Milk Producers' Unions, which purchase raw milk from primary village societies, operate processing plants, market the products, and provide veterinary support and artificial insemination services to the member farmers.

30. (A) I, II, III and IV
Dairy development in India is supported by coordinated infrastructure initiatives, including the Dairy Processing and Infrastructure

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Development Fund, the National Programme for Dairy Development, historical Operation Flood phases, and the Rashtriya Gokul Mission. These initiatives focus directly on cattle productivity, cooperative milk procurement, cold chain logistics, and modern processing plant expansion.

31. (B) Listeria monocytogenes
Listeria monocytogenes is a significant foodborne pathogen capable of growing at refrigeration temperatures. In dairy plants, it is frequently associated with post-pasteurization contamination from environmental sources. Because of its psychrotrophic nature, this bacterium can slowly replicate in pasteurized milk during cold storage, posing serious health risks to vulnerable consumer groups.

32. (D) They limit the temperature rise to under 2 degrees Celsius over 24 hours.
Insulated road tankers are designed with high-performance polyurethane or glass wool insulation between double stainless steel walls. This design ensures that chilled milk can be transported over long distances without mechanical refrigeration, limiting any temperature rise to less than two degrees Celsius over a twenty-four hour transit period, maintaining quality.

33. (A) Total Solids (TS) from fat and specific gravity
Richmond's formula is a standard mathematical equation used in dairy laboratories to calculate the total solids percentage of milk. By utilizing the fat content determined by the Gerber method and the specific gravity measured using a lactometer, the formula provides a rapid, non-destructive estimation without requiring oven-drying methods.

34. (C) The formation of distinct flakes or clots
The sixty-eight percent alcohol test is a rapid screening method used at reception centers to check milk stability. A positive result is indicated by the formation of visible flakes or clots when equal volumes of milk and alcohol are mixed. This indicates high acidity, mineral imbalance, or elevated colostrum levels.

35. (A) Both (A) and (R) are true and (R) is the correct explanation of (A).
The methylene blue reduction test time decreases as the bacterial population in a milk sample increases. Actively multiplying bacteria consume dissolved oxygen as they metabolize nutrients. This cellular respiration lowers the oxidation-reduction potential of the medium, causing the blue methylene dye to reduce into its colorless form much more rapidly.

36. (D) Rosalic acid
Rosalic acid is the primary chemical indicator used to detect alkaline neutralizers, such as sodium carbonate or sodium hydroxide, in adulterated milk. When added to a neutralizer-treated milk sample, rosalic acid reacts with the alkaline substances, producing a characteristic rose-red color, whereas normal milk results in a brownish-yellow hue.

37. (B) Antibiotic residues inhibit starter cultures in cheese and yogurt making.
Antibiotic residues present in raw milk pose a major challenge for dairy processors. These chemical residues are highly resistant to standard pasteurization temperatures and can inhibit or destroy the starter cultures of lactic acid bacteria required for fermenting cheese, yogurt, and cultured dairy products, resulting in production failures.

38. (C) Extending raw milk storage life by inhibiting psychrotrophic bacterial replication
Thermization is a mild thermal process, typically heating raw milk to sixty-five degrees Celsius for fifteen seconds, aimed at reducing the load of psychrotrophic bacteria. This treatment controls the growth of cold-tolerant organisms during extended silo storage, preventing the secretion of heat-resistant lipases and proteases that spoil subsequent dairy products.

39. (D) The relative spacing and angle of the conical discs
In a mechanical cream separator, the internal bowl contains a stack of closely spaced, angled conical discs. These discs divide the milk flow into extremely thin layers, reducing the distance a fat globule must travel to separate. This geometry channels the heavier skim milk outward and the lighter cream inward.

40. (A) I and II
The Bactocatch process utilizes specialized cross-flow microfiltration ceramic membranes to physically separate bacteria and bacterial spores from skim milk. This advanced technology removes over ninety-nine percent of the microbial

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load while avoiding severe heat treatment. The separated concentrate is then sterilized at high temperatures and mixed back with the permeate.

41. (B) Micro-turbulence theory
The micro-turbulence theory of homogenization states that fat globules are disrupted by high-velocity fluid jets exiting the valve. This movement creates intense localized turbulent eddies. When these eddies are smaller than the fat globules, they exert highly concentrated energy and shear stresses that break the globules into smaller units.

42. (B) Decreased surface tension and increased foaming
Homogenization increases the total surface area of fat globules, requiring more milk proteins to adsorb onto the newly formed fat membranes. This reallocation of surface-active proteins alters the physical properties of the milk, leading to a decrease in overall surface tension and a corresponding increase in the tendency of the milk to foam.

43. (A) The temperature increase required to reduce the D-value by a factor of 10
In thermal processing kinetics, the Z-value represents the temperature increase required to reduce the decimal reduction time, or D-value, of a microorganism by ninety percent. This value describes the temperature sensitivity of a specific microbe and is crucial for optimizing pasteurization and sterilization processes to preserve milk quality.

44. (C) To pre-heat incoming raw milk using outgoing pasteurized milk
The regeneration section of an HTST pasteurizer acts as an energy recovery system. It transfers heat from the hot, newly pasteurized milk to the cold, incoming raw milk. This process pre-heats the raw milk and pre-cools the pasteurized milk, significantly reducing the steam and refrigeration demands of the processing plant.

45. (A) P-3, Q-4, R-1, S-2
Low temperature long time pasteurization is a batch process heating milk at sixty-three degrees Celsius for thirty minutes. The flow diversion valve is a safety mechanism in HTST systems. Clarifiers use centrifugal force to remove somatic cells and dirt, while homogenizers employ high-pressure positive displacement pumps to break down fat globules.

46. (C) Lactose and the amino groups of lysine
Maillard browning in sterilized milk is a non-enzymatic chemical reaction occurring at high processing temperatures. It takes place between the reducing sugar lactose and the free amino groups of amino acids, particularly lysine, present in milk proteins. This reaction produces melanoidin pigments, causing a brownish color and a cooked flavor profile.

47. (B) Scraped surface heat exchanger
Scraped surface heat exchangers are designed for processing highly viscous dairy products or those prone to severe surface fouling. They feature internal rotating blades that continuously scrape the heat transfer surfaces, preventing product burn-on, maintaining high heat transfer efficiency, and ensuring uniform, gentle thermal treatment of thick mixtures throughout production.

48. (D) To prevent age gelation and phase separation during storage
Hydrocolloid stabilizers like carrageenan are added to ultra-high temperature processed milk to prevent age gelation and gravity-induced phase separation during long-term ambient storage. By interacting with caseins, they form a weak, stable network that keeps suspended solids in place, preserving a uniform product consistency and texture over its shelf life.

49. (B) 1.5% fat and 9.0% SNF
According to food safety standards in India, double toned milk must be standardized to contain a minimum of one point five percent milk fat and nine point zero percent solids-not-fat. This low-fat, high-protein category is designed to offer consumers a highly nutritious fluid milk product with reduced energy content.

50. (A) I, II and III
Milk adulteration tests use specific reagents to detect foreign additives. Iodine reacts with starch to form a blue complex, while the urease test measures ammonia released from added urea. Picric acid precipitates gelatin to confirm its presence. However, the Gerber test is designed exclusively to measure fat content, not chemical neutralizers.

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51. (A) Whey protein beverage with phytosterols
A whey protein beverage fortified with phytosterols is classified as a functional dairy beverage because it provides health benefits beyond basic nutrition. Phytosterols are plant compounds proven to lower blood cholesterol levels, while whey provides bioactive proteins, making this combination an effective vehicle for delivering targeted physiological benefits.

52. (D) Buffalo milk has more saturated fatty acids and larger sized fat globules.
Buffalo milk differs significantly from cow milk in its lipid profile and physical structure. It contains a higher proportion of saturated fatty acids and features larger average fat globule sizes. These physical and chemical characteristics influence the churning behavior, melting point, and overall texture of products manufactured from buffalo milk fat.

53. (B) Adulteration with water
Diluting milk with water decreases the concentration of dissolved solutes like lactose and mineral salts. This reduction in solute concentration raises the freezing point, making it closer to zero degrees Celsius. Measuring this change with a cryoscope is a highly accurate method for identifying illegal water addition in milk.

54. (C) Buffaloes
Buffaloes are the single largest contributors to India's total milk production, outpacing both indigenous and exotic cow breeds. This dominance is due to the large population of high-yielding buffalo breeds, such as Murrah, and their adaptability, along with a strong consumer preference for milk with a higher fat and solids content.

55. (B) Reception → Clarification → Pasteurization → Homogenization → Chilling
In a commercial pasteurization plant, raw milk follows a strict processing sequence. After reception, the milk undergoes clarification to remove physical impurities and somatic cells. It is then pasteurized to destroy pathogens, homogenized to prevent cream separation, and immediately chilled to safe storage temperatures before being packaged or stored.

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56. (A) Regular herd testing for brucellosis and tuberculosis disease
Regular screening of dairy cattle for zoonotic pathogens, including Brucella abortus and Mycobacterium bovis, is essential for farm safety. Identifying and isolating infected animals prevents the direct transmission of these highly infectious pathogens to agricultural workers and eliminates the risk of transmitting these dangerous diseases through raw dairy secretions.

57. (B) The Vendor Model
The vendor milk procurement model relies on private middle-men or contractors who collect raw milk from small-scale rural producers and sell it directly to urban consumers or processing plants. This traditional system often lacks transparency in pricing and quality control, leading to high risks of adulteration and fluctuating returns for farmers.

58. (B) Blue → Lilac → Mauve → Pink → White
The resazurin test measures the microbial quality of milk by observing the progressive chemical reduction of a color indicator. Active bacterial enzymes reduce the dye, causing a color shift from its initial blue state to lilac, mauve, pink, and finally to a completely white, decolorized form, indicating high bacterial contamination.

59. (B) $0.13 - 0.17\%$
The natural titratable acidity of fresh bovine milk typically ranges between zero point thirteen and zero point seventeen percent lactic acid. This apparent acidity is caused by the presence of proteins, citrates, phosphates, and carbon dioxide. Any acidity level above this range suggests bacterial fermentation and lactic acid production.

60. (A) I, II, III and IV
Clean milk production depends on controlling direct sources of microbial contamination. Critical control points include ensuring milker hygiene, maintaining animal health and udder cleanliness, sanitizing milking equipment, and rapidly cooling milk. While the animal breed affects milk composition, it does not directly impact bacterial entry during the milking process.

61. (D) Contaminated feed, water, and environmental runoff
Heavy metal contamination, including lead and cadmium, in raw milk is primarily caused by animals consuming contaminated feed and water. These toxic metals are absorbed into the bloodstream of dairy cows from environmental pollution, agricultural runoff, and industrial emissions, and are subsequently secreted directly into the milk during lactation.

62. (C) Potassium dichromate
Potassium dichromate is a legally permitted chemical preservative added to milk samples destined exclusively for laboratory analysis. It prevents microbial growth and enzymatic degradation, maintaining the physical and chemical integrity of the sample during transport and storage. However, because of its high toxicity, it cannot be used in milk for human consumption.

63. (B) Have a single outlet and do not separate the fat
Centrifugal clarifiers are designed to remove physical debris, somatic cells, and heavy impurities from milk without separating the fat. Unlike cream separators, which use dual outlets to divide milk into cream and skim milk, a clarifier has a single outlet for the treated whole milk, keeping the fat content unchanged.

64. (B) 1.4 micrometers
Microfiltration processes designed for bacterial removal from milk typically use ceramic membranes with a pore size of approximately one point four micrometers. This specific pore size allows milk proteins and lactose to pass through in the permeate while retaining larger bacterial cells and spores, achieving physical sterilization without using heat.

65. (A) II, I, III, IV
Thermal treatments in dairy processing are ranked by increasing lethality. Thermization is a mild, low-temperature heating step. Low temperature long time pasteurization provides a moderate heat treatment. Ultra-high temperature processing uses high temperatures with short holding times, while in-bottle sterilization represents the most severe thermal treatment, utilizing extended high heating.

66. (B) 2.0 micrometers
The Farrall index is a microscopic method used to evaluate homogenization efficiency. It requires that the majority of fat globules in the homogenized milk sample do not exceed two point zero micrometers in diameter. Reducing globules to this size prevents them from clustering and rising, ensuring the stability of the emulsion.

67. (C) 121.1 degrees Celsius
The thermal death time, or F-value, is internationally standardized to a reference temperature of one hundred and twenty-one point one degrees Celsius. This reference value measures the total lethality of a heat sterilization process, allowing engineers and food scientists to compare the sterilization efficiency of different thermal profiles for canned and packaged dairy products.

68. (D) The milk temperature falls below the pasteurization limit.
The automatic flow diversion valve in an HTST system is a critical safety device. It is triggered to divert the milk flow back to the balance tank if the temperature falls below the pasteurization limit. This mechanism ensures that only properly heated, pasteurized milk can proceed to the cooling and packaging stages.

69. (B) Alkaline phosphatase
Alkaline phosphatase is the standard indicator enzyme used to verify pasteurization efficiency in dairy plants. Because this natural milk enzyme is slightly more heat-resistant than vegetative pathogens, its complete denaturation confirms that the pasteurization temperature and holding time were sufficient to destroy pathogens and ensure the safety of the milk.

70. (C) Saturated steam under high pressure
Hydrostatic and other continuous sterilizers for canned or bottled milk use high-pressure saturated steam as the heating medium. This pressurized steam achieves and maintains the high temperatures, typically between one hundred and fifteen and one hundred and twenty degrees Celsius, required to destroy bacterial spores inside the sealed glass or plastic containers.

71. (D) More pronounced cooked flavor from slower heating and cooling
Indirect ultra-high temperature processing heat-treats milk across stainless steel plates or

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tubes. This method results in slower heating and cooling rates compared to direct steam injection. The extended exposure to heat increases the denaturation of whey proteins, resulting in a more pronounced cooked flavor and a higher rate of Maillard browning.

72. (A) Drying with hot sterile air or radiation
After applying hydrogen peroxide to sterilize packaging materials in aseptic filling systems, the chemical must be removed before filling. This is achieved by blowing high-velocity hot sterile air or applying radiation across the packaging surface, which evaporates and decomposes the sterilant into harmless water vapor and oxygen, ensuring no chemical residues remain.

73. (B) Enrichment
Fortifying market milk with Vitamins A and D is an example of enrichment, a public health strategy used to restore lost nutrients or add essential vitamins to common foods. Because milk is widely consumed, adding these vitamins helps address dietary deficiencies in the population, promoting bone health and supporting immune function.

74. (B) Kappa-casein
In sterilized flavored milk, carrageenan stabilizes the beverage by interacting with kappa-casein. The negatively charged ester sulfate groups on the carrageenan molecule bind to the positively charged regions of the kappa-casein on the surface of casein micelles. This interaction forms a weak, stabilizing network that keeps heavy cocoa particles from settling.

75. (A) Both (A) and (R) are true and (R) is the correct explanation of (A).
Whey-based beverages have gained significant popularity as functional sports drinks because of their high concentration of high-quality proteins. These dairy proteins are naturally rich in branched-chain amino acids, such as leucine, isoleucine, and valine, which are easily absorbed and play a crucial role in promoting muscle protein synthesis and recovery.

76. (C) Smaller fat globules and more short- and medium-chain fatty acids
Goat milk is highly digestible because of its physical and chemical properties. Its fat globules are smaller than those in cow milk, providing a larger surface area for digestive lipases to act upon. Additionally, it contains higher levels of short- and medium-chain fatty acids, which are rapidly absorbed and metabolized.

77. (B) 100.17 degrees Celsius
The boiling point of normal cow milk is approximately one hundred point seventeen degrees Celsius at standard atmospheric pressure, which is slightly higher than that of pure water. This elevation is caused by the presence of dissolved low-molecular-weight solutes, such as lactose and mineral salts, which lower the vapor pressure of the solvent.

78. (D) 6.0%
Food safety regulations in India specify that full cream milk sold in the commercial market must contain a minimum milk fat content of six point zero percent. This standard ensures that the milk maintains its rich flavor and nutritional profile, providing a high-energy product for consumers and establishing clear benchmarks for dairy processors.

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79. (B) The primary milk producer members
The Anand Pattern cooperative model is designed to ensure that the economic benefits and profits of dairy processing are distributed to the primary milk producer members. By eliminating middle-men, this model ensures that farmers receive fair, transparent prices for their milk, along with surplus-sharing bonuses and essential veterinary and agricultural support.

80. (A) I and II
The National Programme for Dairy Development focuses on building and modernizing dairy infrastructure. The scheme provides financial and technical assistance to establish village cooling systems and expand cooperative processing plants. However, the program does not ban private participation; instead, it aims to strengthen the cooperative sector to help rural producers.

81. (A) Flush out bacteria concentrated in the teat canal
Discarding the first streams of milk, known as foremilk, is a key practice in clean milk production. Bacteria can multiply in the teat canal between milkings, and removing this initial milk flushes out these microorganisms, preventing them from contaminating the bulk

milk supply and reducing the overall bacterial load.

82. (C) The direct expansion evaporator plate
In a bulk milk cooler, the inner stainless steel wall is integrated with a direct expansion evaporator plate. This plate contains circulating refrigerant that directly contacts the bottom of the milk tank. This design enables rapid heat transfer from the warm milk, cooling it to four degrees Celsius to preserve its microbial quality.

83. (A) High-volume milk with lower fat levels, such as cow milk
Pricing milk solely on its fat content disadvantages dairy farmers who produce high-volume milk with lower fat levels, such as cow milk. This pricing method ignores the economic value of solids-not-fat components like proteins and lactose, which are abundant in cow milk, leading to unfair compensation and discouraging cow milk production.

84. (C) 0.24% or higher
The clot on boiling test is a rapid platform method to check milk stability. When milk reaches a titratable acidity of zero point twenty-four percent or higher, the calcium caseinate complex becomes highly unstable. At this level of acidity, heating causes the milk proteins to coagulate and form visible clots.

85. (A) P-2, Q-1, R-4, S-3
Adulterants are added to milk for specific fraudulent purposes. Urea is used to falsely increase the non-protein nitrogen and solids-not-fat content. Starch is added to increase viscosity and mimic the specific gravity of thick milk. Sodium bicarbonate neutralizes developed acidity, while water is added to increase total volume and maximize profits.

86. (C) Butter
Pesticide residues, such as organochlorines, are lipophilic and tend to dissolve in fats. When contaminated raw milk is processed, these chemical residues partition into the fat phase. As a result, they concentrate in high-fat dairy products like butter, ghee, and cream, rather than remaining in the aqueous skim milk or whey.

87. (D) Hypothiocyanite
The lactoperoxidase system is a natural preservation method in raw milk. The lactoperoxidase enzyme catalyzes the oxidation of thiocyanate by hydrogen peroxide, producing hypothiocyanite. This short-lived compound has potent antimicrobial properties that inhibit bacterial metabolism and replication, extending the shelf life of raw milk in areas without refrigeration.

88. (A) Higher temperature lowers milk viscosity, increasing separation efficiency.
Milk temperature significantly affects centrifugal cream separation. Heating milk to approximately forty to fifty degrees Celsius reduces the viscosity of the liquid phase. According to Stokes' Law, lower viscosity increases the rising velocity of fat globules, allowing for more rapid and complete separation of the cream from the skim milk.

89. (B) A small fraction $(2-3\%)$ of milk volume is lost as bactofugate sludge.
A primary limitation of bactofugation is that a small portion of the milk, typically two to three percent, is separated as bactofugate sludge along with the bacterial spores. This sludge contains concentrated milk solids and must be sterilized at ultra-high temperatures before being mixed back into the milk to minimize yield losses.

90. (A) I, II and III
Homogenization is explained by three main theories of fat globule disruption: shear theory, cavitation theory, and micro-turbulence theory. These theories describe how physical forces, such as high-velocity shear, rapid pressure changes causing cavitation, and localized turbulent eddies, break up fat globules. Osmotic pressure changes, however, do not play a role in this process.

91. (A) Reducing the fat globule size and increasing density via protein adsorption
Homogenization prevents cream line formation by reducing the average fat globule size to under two micrometers. This reduction in size increases the total surface area of the fat, which is quickly covered by adsorbed casein micelles and whey proteins, increasing the density of the globules and preventing them from rising to the surface.

92. (C) 6 minutes
In microbial thermal death kinetics, the D-value is the heating time required to achieve a ninety percent reduction, or a one-log reduction, in a microbial population at a specific temperature.

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To achieve a three-log reduction, the milk must be held at that temperature for three times the D-value, which equals six minutes.

93. (D) To ensure the pipe remains full and prevents air pockets for uniform holding
The holding tube of an HTST pasteurizer is sloped upwards at a minimum angle of two percent. This design ensures the pipe remains completely filled with milk, preventing air pockets or bubbles from forming. Keeping the tube full ensures uniform flow and holding time, guaranteeing that all milk receives proper thermal pasteurization.

94. (C) Its thermal death time curve is slightly above but parallel to Mycobacterium tuberculosis.
Alkaline phosphatase is used to verify pasteurization because its thermal inactivation curve is slightly above but parallel to that of pathogens like Mycobacterium tuberculosis. Since the enzyme is more heat-resistant than these pathogens, its complete inactivation confirms that the milk has been heated sufficiently to destroy any vegetative pathogens.

95. (B) Maillard reactions between amino acids and sugars
The brownish color that develops in milk during in-bottle sterilization is caused by the Maillard reaction. This non-enzymatic browning occurs when the high heat of sterilization causes the reducing sugar lactose to react with the amino groups of lysine in milk proteins, producing melanoidin pigments and characteristic caramelized flavors.

96. (D) By flash vacuum cooling chambers
Direct steam injection heats milk rapidly but dilutes it due to steam condensation. To remove this added water, the hot milk is passed into a flash vacuum cooling chamber. The vacuum causes the milk to cool rapidly by evaporation, releasing the exact amount of water that was introduced by the steam and restoring original composition.

97. (A) Tetra Pak multi-layer cartons
Commercial aseptic packaging systems use form-fill-seal technology, commonly seen in multi-layer cartons. In this continuous process, a sterilized roll of packaging material is formed into a tube, filled with sterilized milk under aseptic conditions, and then sealed and cut below the liquid level, preventing contamination and ensuring a long ambient shelf life.

98. (C) Form a stable emulsion of butter oil in the aqueous skim milk phase
Recombined milk is produced by mixing skim milk powder, butter oil, and water. Because butter oil is highly hydrophobic, it does not disperse easily in water. Homogenization is necessary to break the butter oil into tiny droplets and cover them with milk proteins, forming a stable emulsion that prevents fat separation during storage.

99. (A) Increasing heat resistance of microbial spores
Adding sugar to flavored milk increases the solute concentration of the fluid, which lowers water activity. This reduction in water activity increases the heat resistance of bacterial spores, requiring processors to carefully monitor and adjust thermal sterilization parameters to ensure complete destruction of these resistant microorganisms and maintain product safety.

100. (A) I, II, III and IV
Functional dairy beverages are formulated with ingredients that offer health benefits beyond basic nutrition. Common additives include whey protein concentrates, probiotic bacterial cultures, prebiotic dietary fibers, and plant sterols, which help improve gut health and manage cholesterol. Chemical neutralizers, however, are illegal adulterants and are not used in these products.

101. (B) Insulin-like proteins resistant to stomach degradation
Camel milk contains high concentrations of unique insulin-like proteins that do not form coagulum in the stomach. This structure allows these proteins to resist enzymatic degradation in the acidic gastric environment, enabling them to pass directly into the intestines for absorption, which makes them highly relevant for research in managing diabetes.

102. (B) 0.5%
According to international Codex standards, skimmed milk must have a maximum fat content of zero point five percent. This standard ensures that nearly all milk fat has been removed through centrifugal separation, providing consumers with a low-calorie, high-protein dairy product with minimal fat content while maintaining milk protein standards.

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103. (C) 6.5 to 6.7
The pH of freshly drawn, normal cow milk typically ranges between six point five and six point seven, representing a slightly acidic character. This normal range is determined by the presence of natural milk constituents like caseins, phosphates, citrates, and dissolved carbon dioxide. Any significant shift from this range indicates mastitis or bacterial fermentation.

104. (C) Phase III
Phase Three of Operation Flood focused on consolidating the cooperative movement and expanding dairy infrastructure across India's major milk sheds. This phase strengthened primary cooperatives, improved veterinary services, expanded artificial insemination programs, and upgraded processing facilities, helping to establish the cooperative network as a key driver of national milk production.

105. (B) Modernize dairy processing plants and machinery in cooperatives
The primary mandate of the Dairy Processing and Infrastructure Development Fund is to modernize dairy processing plants and machinery in cooperative unions. The scheme provides subsidized loans to upgrade old equipment, install energy-efficient technologies, and expand milk powder and value-added product manufacturing capacities, strengthening the cooperative dairy sector.

106. (B) Udder health and subclinical mastitis presence
Somatic cell count is a key indicator of udder health and subclinical mastitis in dairy herds. These cells consist of epithelial cells and immune cells, such as white blood cells, which enter the milk in response to bacterial infection or inflammation of the mammary tissue, allowing herd health monitoring.

107. (A) Lack of transparency in raw milk pricing and weighing.
A key limitation of the vendor procurement model compared to the cooperative model is the lack of transparency in weighing and pricing. Because private middle-men often determine prices arbitrarily without using standardized fat and SNF testing equipment, rural milk producers are vulnerable to exploitation and receive highly unstable returns for their milk.

108. (C) Two-axis pricing
The two-axis pricing system calculates milk payment based on both the fat and solids-not-fat content of the raw milk. By valuing both fat and non-fat solids, this model ensures fair compensation for farmers, discourages the dilution of milk, and encourages the production of high-quality milk from both cows and buffaloes.

109. (D) The smell, taste, appearance, and temperature
An organoleptic evaluation is a rapid quality test performed immediately upon raw milk reception. It involves using the sensory organs to assess the smell, taste, appearance, and temperature of the incoming milk. This screening allows trained operators to quickly identify off-flavors, visual contamination, or souring, preventing substandard batches from entering processing lines.

110. (C) Blue-black
Detecting starch in milk relies on a chemical reaction with iodine solution. When iodine is added to a milk sample adulterated with starch, it interacts with the amylose molecules to form a characteristic blue-black complex. This distinct color change indicates the presence of starch, which is used to artificially increase solids-not-fat.

111. (B) Aflatoxin B_1
Aflatoxin M_1 is a toxic metabolite excreted in the milk of dairy animals that have consumed feed contaminated with aflatoxin B_1. This parent mycotoxin is produced by Aspergillus molds growing on poorly stored grains. After ingestion, the liver metabolizes aflatoxin B_1 into aflatoxin M_1, which is then secreted directly into the milk.

112. (D) Activate endogenous lactoperoxidase
Adding trace amounts of hydrogen peroxide to raw milk in rural collection centers is designed to activate the natural lactoperoxidase preservation system. This system requires low levels of hydrogen peroxide and thiocyanate to produce hypothiocyanite, a natural antimicrobial compound that inhibits bacterial growth and preserves raw milk quality in areas without refrigeration.

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113. (A) Skim milk having a higher density than cream
In a cream separator, the separation of phases is driven by differences in density under centrifugal force. Because skim milk contains water, proteins, and minerals, it has a higher density than the fat-rich cream. The centrifugal force throws the heavier skim milk outward to the bowl wall, while the lighter cream moves inward.

114. (C) Hard and semi-hard cheeses
Bactofugation is commonly applied to milk used in manufacturing hard and semi-hard cheeses. These cheeses are susceptible to "late blowing," a defect caused by the outgrowth of anaerobic, gas-producing Clostridium tyrobutyricum spores. Because these spores are highly heat-resistant, high-speed centrifugation is used to remove them mechanically before fermentation.

115. (A) Both (A) and (R) are true and (R) is the correct explanation of (A).
In a two-stage homogenizer, the second stage operates at a lower pressure than the first. While the first stage uses high pressure to break up fat globules, these small globules tend to cluster together afterward. The second stage uses lower pressure to break up these clusters, ensuring a stable, uniform emulsion in the final product.

116. (C) Poor homogenization efficiency with many large fat globules remaining
The Farrall index is a specialized parameter used to measure the efficiency of milk homogenization. A high index value indicates poor homogenization efficiency, meaning a significant number of large fat globules remain in the milk. This can lead to rapid creaming and phase separation during storage, reducing the overall quality and shelf life of the product.

117. (A) Clostridium botulinum
Neutral pH foods, such as milk, support the growth of pathogenic spore-forming bacteria. The highly heat-resistant, anaerobic pathogen Clostridium botulinum is the primary target organism used to establish the thermal death time and calculate the safety margin for commercial sterilization. Achieving a standard twelve-decimal reduction of these spores ensures the microbiological safety of low-acid packaged foods.

118. (D) 63 degrees Celsius for 30 minutes
Low Temperature Long Time pasteurization is a traditional batch process designed to destroy pathogenic microorganisms in fluid milk. It involves heating every particle of milk to sixty-three degrees Celsius and holding it at that temperature continuously for thirty minutes. This treatment effectively eliminates harmful pathogens while preserving most of the nutritional and sensory qualities of raw milk.

119. (B) Microbial phosphatase produced during cold storage
Alkaline phosphatase is a natural enzyme in raw milk that is inactivated during standard pasteurization. However, certain psychrotrophic bacteria can multiply during extended cold storage of raw milk, producing microbial phosphatases that are exceptionally heat-stable. These bacterial enzymes can survive thermal pasteurization, leading to a positive result even though the pasteurization process was fully adequate.

120. (C) To accelerate heat transfer and prevent surface burn-on
Continuous rotary sterilizers process bottled milk by utilizing mechanical agitation during the heating cycle. Agitating the bottles prevents the milk from remaining static against the hot inner surfaces of the container. This movement greatly accelerates convective heat transfer within the product, ensures uniform temperature distribution, and prevents localized overheating or brown caramelization defects on the glass.

121. (D) Continuously scrape surfaces to prevent product fouling
Highly viscous dairy products like cheese sauces and desserts are highly susceptible to thermal burning and fouling in standard heat exchangers. Scraped surface heat exchangers use rotating blades to continuously clear product from the heat transfer walls. This constant mechanical agitation prevents the formation of a stagnant boundary layer, enhances heat transfer, and maintains product consistency.

122. (A) Enhances the sporicidal efficacy of hydrogen peroxide
Combining chemical sterilants with physical treatments is a highly effective method for decontamination. When ultraviolet radiation is applied to packaging materials containing residual

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hydrogen peroxide, a synergistic reaction occurs. This combination generates highly reactive hydroxyl free radicals that rapidly destroy bacterial spores. It achieves higher sterilization efficiency than using either the chemical agent or light treatment alone.

123. (B) Anhydrous milk fat (or purified butter oil)
Reconstituted milk is produced by adding potable water back to dehydrated milk components, such as skim milk powder or whole milk powder. It must represent the original fluid milk composition without any external fat modifications. In contrast, recombined milk involves combining skim milk powder, potable water, and anhydrous milk fat or butter oil to create a standardized fluid product.

124. (B) The minimum required milk solid content
Standardized dairy regulations differentiate between flavored milk and dairy drinks based on composition. Flavored milk must contain a high proportion of actual milk solids, maintaining the essential nutritional profile of the original fluid milk. Conversely, dairy drinks can have a lower concentration of milk solids and often contain added water, stabilizers, sugars, and artificial flavorings or colors.

125. (A) P-3, Q-2, R-1, S-4
Normal cow milk exhibits standard physical and chemical properties. The typical pH of fresh cow milk is slightly acidic, hovering around six point six. Its freezing point is approximately minus zero point five four zero degrees Celsius. The specific gravity ranges from one point zero two eight to one point zero three two, while its boiling point is slightly higher than water.

126. (C) Total solids content
Sheep milk has a high concentration of total solids, which includes both fat and protein fractions. This dense nutrient profile makes it highly suitable for producing premium artisanal and gourmet cheeses. The higher solids yield more curd per unit volume of milk, reducing the volume of whey generated and improving the overall efficiency and texture of cheese manufacturing.

127. (D) 3.0% and 8.5%
Toned milk is a standardized dairy product widely consumed in developing regions to optimize nutritional availability and cost. According to food safety and regulatory standards, toned milk must contain a minimum milk fat level of three point zero percent. Additionally, it must maintain a minimum solids-not-fat content of eight point five percent to ensure adequate protein and calcium.

128. (C) Lactose and dissolved minerals
The refractive index of milk is a measure of light bending through the fluid and is primarily influenced by soluble constituents. Lactose and dissolved mineral salts, which reside in the aqueous phase, have the most significant and consistent impact on this optical property. Suspended fat globules and large proteins scatter light but do not alter the refractive index in the same manner.

129. (B) Verghese Kurien
Operation Flood is celebrated as the largest dairy development program in human history, transforming India into a self-sufficient milk producer. Dr. Verghese Kurien is universally recognized as the pioneer of this movement. His leadership established the multi-tier cooperative model known as the Anand Pattern, empowering rural producers and securing dairy development nationwide.

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130. (D) Antimicrobial resistance in pathogens
Modern dairy regulatory frameworks prioritize milk safety by monitoring emerging biological threats. The rise of antimicrobial resistance among zoonotic and foodborne pathogens is a critical concern. Standard dairy cattle treatments can select for resistant bacterial strains, which may enter the food supply. Robust surveillance of this resistance is essential to protect public health and maintain therapeutic efficacy.

131. (A) Prevent contaminants from entering milk during harvesting
Maintaining hygiene at the farm level is critical for raw milk quality. Clipping the flanks and udders of dairy cows removes long hairs that easily trap dirt, manure, and bedding material. By keeping these physical areas clean, the risk of particulate matter and associated environmental bacteria falling into the milk bucket or milking unit during harvesting is significantly minimized.

132. (A) 2 to 4 hours
Chilling milk immediately after extraction is critical to slow down the growth of bacteria.

Chilling raw milk to four degrees Celsius within two to four hours of harvesting effectively extends its storage quality. This rapid temperature reduction arrests the logarithmic replication phase of mesophilic contaminants, maintaining low microbial counts before the milk is transported to the processing plant.

133. (A) Adulterate the milk with water
Implementing milk payment systems purely based on volume, without analyzing composition or safety parameters, creates an adverse economic incentive. Farmers are motivated to maximize liquid volume to increase payout. This often leads to the direct adulteration of milk with water. Incorporating mandatory fat and solids-not-fat testing prevents this dishonest practice and protects milk quality throughout the cooperative.

134. (D) Oxidation-reduction (redox) potential
The methylene blue reduction test is a rapid diagnostic tool used to estimate the bacterial load of raw milk. Active bacteria consume dissolved oxygen during respiration, which alters the environment of the milk. This biochemical activity decreases the overall oxidation-reduction potential, causing the added blue dye indicator to change from its oxidized colored state to a reduced colorless state.

135. (B) Add sulfuric acid → Add milk → Add amyl alcohol → Centrifuge → Read fat percentage
The Gerber method is a standardized analytical test used to determine milk fat content. The process must follow a precise sequence. First, concentrated sulfuric acid is added to dissolve proteins and release fat. Next, milk is carefully introduced, followed by amyl alcohol to facilitate separation. The mixture is then centrifuged and placed in a water bath to read the fat percentage.

136. (C) Emulsifiers to suspend vegetable fat
Synthetic milk is a fraudulent mixture fabricated using non-dairy components. Detergents or surfactants are added to these mixtures primarily to serve as powerful chemical emulsifiers. They reduce interfacial tension, allowing cheap vegetable oils to form a stable emulsion with water. This mimics the physical appearance of natural milk fat globules, preventing rapid separation and settling during storage.

137. (D) Inductively Coupled Plasma Mass Spectrometry
Inductively Coupled Plasma Mass Spectrometry is the premier analytical standard for detecting trace heavy metals in complex biological samples like milk. This sophisticated technique offers exceptional sensitivity, extremely low detection limits, and high precision. It can simultaneously quantify multiple toxic elements, such as lead, arsenic, and cadmium, ensuring strict compliance with international food safety and contaminant guidelines.

138. (A) Raw milk preservation in areas lacking cold chain systems
Although regulatory guidelines prohibit the addition of preservatives to consumer milk, exceptions are made under extreme conditions. In developing regions that lack established electrical grids and cold chain logistics, raw milk is highly susceptible to rapid souring. Controlled activation of the natural lactoperoxidase system or minimal addition of approved stabilizers serves to temporarily preserve raw milk until safe processing can occur.

139. (B) They divide milk into thin layers to reduce fat settling distance
In a centrifugal cream separator, milk enters a bowl containing closely spaced conical discs. These discs divide the fluid into very thin layers, which drastically reduces the physical distance that fat globules must travel to separate from the heavier skim milk. This design optimizes separation efficiency by utilizing centrifugal force to accelerate the process based on density differences.

140. (B) Prevent rapid membrane fouling by casein micelles
The Bactocatch microfiltration process is used to remove bacteria and spores from skim milk. Maintaining a uniform trans-membrane pressure is critical during filtration. This pressure profile prevents rapid membrane fouling and gel layer formation by large casein micelles. Consequently, the whey proteins and water pass freely, while bacterial cells are concentrated and removed in a stable, continuous operational cycle.

141. (A) Low-fat or highly viscous products
Single-stage homogenization is sufficient for dairy products with low fat content or high viscosity. In these products, there is a lower probability of

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fat globule coalescing and forming clusters after exiting the valve. High-fat products, however, require a second stage of homogenization to disrupt the fat clusters that naturally form during single-stage treatment, ensuring long-term product stability.

142. (C) Disrupting the globule membrane exposes fat to native lipase
Raw milk contains active, native lipase enzymes that can hydrolyze fats. Homogenization disrupts the protective outer fat globule membrane, significantly increasing the total surface area of the fat. If milk is not pasteurized immediately after homogenization to denature these lipase enzymes, they will rapidly degrade the newly exposed triglycerides, leading to the rapid development of rancid off-flavors.

143. (D) First-order kinetics
Thermal death time calculations are based on the fundamental assumption that bacterial destruction follows first-order kinetics. This log-linear model indicates that at a constant lethal temperature, a consistent percentage of the surviving microbial population is destroyed during each unit of exposure time. This relationship allows food engineers to precisely calculate necessary thermal pasteurization and sterilization processes.

144. (C) Maximize heat transfer efficiency and prevent boundary buildup
Plate heat exchangers used in milk pasteurization are designed to promote highly turbulent flow. Turbulent fluid dynamics increase the heat transfer rate by disrupting the slow-moving boundary layer that forms adjacent to the plate surfaces. This turbulence prevents localized overheating and milk fouling on the stainless steel plates, maintaining high operational efficiency during extended processing runs.

145. (B) I, II, III, IV
Commercial aseptic packaging of ultra-high temperature milk requires a precise sequence of operations to ensure sterility. First, the packaging material is chemically sterilized using hydrogen peroxide. Next, a sterile environment is established and maintained within the filling chamber. The sterilized milk is then filled into the clean package, which is immediately hermetically sealed to prevent any post-process contamination.

146. (D) Post-pasteurization contamination of the final product
Coliform bacteria are highly sensitive to heat and are easily destroyed during standard pasteurization. Consequently, detecting coliforms in pasteurized milk serves as a key indicator of hygienic failure within the dairy plant. It indicates post-pasteurization contamination, which can occur due to unhygienic filling lines, contaminated packaging materials, or faulty equipment that allows raw milk to bypass treatment.

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147. (A) Beta-lactoglobulin
Thermal treatment of milk denatures whey proteins, initiating complex biochemical interactions. The principal whey protein fraction, beta-lactoglobulin, contains a highly reactive free sulfhydryl group that is exposed during heating. This group forms a stable covalent disulfide bond with the kappa-casein present on the outer surface of casein micelles, modifying the cheese-making properties and heat stability of milk.

148. (C) It requires culinary-grade, chemical-free steam
Direct steam injection systems heat milk instantly by mixing it directly with pressurized steam. A major limitation of this system is the requirement for ultra-pure, culinary-grade steam. The steam must be completely free of chemical contaminants, scale inhibitors, and boiler water additives. Any chemical residue in the steam will directly transfer to the milk, compromising product safety and quality.

149. (A) Deficit in local raw milk production
Reconstituted milk is a vital dairy alternative utilized in areas that face severe shortages in local milk production. In arid, remote, or urbanized regions where dairy farming is unfeasible, milk powders are imported. These dry components are rehydrated with safe, potable water to provide a consistent, cost-effective source of fluid milk that meets the nutritional demands of consumers.

150. (D) Riboflavin
Riboflavin, also known as vitamin B_2, is highly sensitive to light energy. When milk is stored in clear glass or plastic bottles, exposure to light initiates the photodegradation of riboflavin. This chemical process generates reactive oxygen species, which oxidize milk lipids and cause off-flavors. Using opaque or amber packaging

materials prevents this nutrient loss and preserves the sensory profile.

151. (B) Lower serum cholesterol levels
Functional dairy beverages are designed to deliver targeted health benefits. Incorporating plant sterols or phytosterols into these drinks is an effective way to help lower blood cholesterol levels. These compounds compete with cholesterol for absorption in the human digestive system, reducing the amount of dietary and biliary cholesterol absorbed, which in turn decreases overall serum low-density lipoprotein levels.

152. (C) Fat globules and casein micelles
The characteristic white color of milk is an optical phenomenon caused by the scattering of light. Milk is an emulsion containing suspended fat globules and colloidal casein micelles. These microscopic particles are distributed throughout the aqueous phase, reflecting and scattering all wavelengths of visible light. This multi-directional scattering prevents light transmission, giving the liquid its typical opaque and white appearance.

153. (C) 6.0 to 8.0%
Buffalo milk is highly valued in the dairy industry due to its dense composition and rich nutritional profile. The average fat content of pure, unadulterated buffalo milk typically ranges between six point zero and eight point zero percent. This high fat percentage is nearly double that of standard cow milk, making it ideal for manufacturing premium butter, ghee, and cheeses.

154. (C) The temperature of measurement and the concentrations of fat and SNF
Specific gravity is a key physical parameter used to assess milk quality and detect potential water adulteration. This value is determined by the balance of milk fat, solids-not-fat, and water. Because fat has a lower density and solids-not-fat has a higher density than water, their concentrations, alongside the exact measurement temperature, dictate the final specific gravity reading.

155. (A) Both A and R are true and R is the correct explanation of A
The Anand Pattern is a highly successful cooperative structure that eliminates exploitative middlemen from the dairy supply chain. By organizing smallholder farmers into local village societies, milk is procured directly from the producers. These societies then supply the district-level cooperative unions, which manage processing and marketing, ensuring that a high percentage of consumer spending returns to farmers.

156. (B) Hilly and backward districts
The National Programme for Dairy Development is a major policy initiative in India aimed at strengthening dairy infrastructure. This government program offers targeted financial assistance to establish processing and chilling networks, with a special focus on hilly, remote, and economically backward districts. This strategic support helps integrate smallholder farmers in these regions into the formal dairy economy.

157. (A) Coliforms
Coliform bacteria are standard indicators of fecal contamination and poor sanitation during milk harvesting. These microorganisms thrive in soil, manure, and on unwashed udders. When dairy farms fail to implement proper hygiene practices, coliforms can easily enter the raw milk supply. Monitoring coliform counts helps assess overall farm sanitation and the safety of the raw milk collected.

158. (C) Polyurethane foam insulation
Insulated milk tankers are designed to transport chilled raw milk over long distances without active refrigeration. To minimize heat gain from the surrounding environment, these tankers utilize high-performance polyurethane foam insulation between the inner stainless steel tank and the outer jacket. This insulation effectively blocks thermal conduction and radiation, keeping the milk below four degrees Celsius during transit.

159. (D) An additional payment for exceeding standard parameters
Premium milk pricing structures are designed to encourage farmers to deliver clean, high-quality milk. A quality premium is an additional financial incentive paid to dairy farmers who exceed standard parameters. These benchmarks often include maintaining low bacterial counts, minimal somatic cell counts, and high concentrations of solids, rewarding producers for implementing excellent management and hygienic practices on the farm.

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160. (C) Faint pink
The titratable acidity test measures the lactic acid content in milk by titrating it against a standardized sodium hydroxide solution. Phenolphthalein is added as a pH indicator. As the alkaline titrant neutralizes the acidic components in the milk, the pH rises. The endpoint of this titration is indicated when the sample transitions to a stable, faint pink color.

161. (B) Restore specific gravity and solids-not-fat (SNF) after water dilution
Adulteration of milk with water decreases its natural density, fat content, and solids-not-fat. To conceal this dilution during quality testing, fraudulent operators add cheap cane sugar. The dissolved sucrose increases the overall solids-not-fat reading and restores the specific gravity to a normal range, helping the watered-down milk temporarily pass basic density-based quality checks.

162. (D) Cause allergic reactions and promote antimicrobial resistance
Antibiotic residues in the milk supply present a major public health hazard. When consumers ingest milk containing low levels of veterinary drugs, it can trigger severe allergic reactions in sensitive individuals. Furthermore, chronic exposure to these low-level residues promotes the selection and spread of antimicrobial-resistant bacterial pathogens, making standard medical treatments less effective over time.

163. (A) 63 to 65 degrees Celsius for 15 seconds
Thermization is a mild thermal treatment applied to raw milk to extend its storage life before processing. It is performed at sixty-three to sixty-five degrees Celsius for fifteen seconds. This process destroys most psychrotrophic bacteria, which produce heat-stable lipases and proteases, without fully pasteurizing the milk or denaturing its natural enzymes and starter cultures.

164. (C) Separator slime
During centrifugal clarification, raw milk is subjected to high centrifugal forces inside a rotating bowl. This process separates heavy particulate matter, including somatic cells, dust, hair, and large bacterial aggregates, from the milk. These dense impurities deposit along the inner walls of the centrifuge bowl, forming a thick, gray residue commonly known as separator slime.

165. (A) P-3, Q-4, R-1, S-2
Dairy processing equipment operates based on distinct physical principles. Tubular heat exchangers utilize convective heat transfer across a metal wall, whereas direct steam injectors transfer latent heat directly into milk. Homogenizing valves break down fat globules using high-pressure shear and cavitation, and centrifugal separators use density differences under a centrifugal field to separate cream.

166. (D) Fat to casein
Homogenization reduces fat globule size and increases their surface area. The newly created fat surfaces must be quickly covered by surfactant proteins to prevent them from coalescing. If the ratio of fat to casein is too high, there will be insufficient casein proteins available to stabilize the new fat membranes, leading to fat globule clustering and creaming.

167. (B) 3 minutes at 121.1 degrees Celsius
The thermal death time, or F-value, measures the sterilization capacity of a heat treatment. An F_0 value of three means the process delivers a thermal lethality equivalent to holding the product at a reference temperature of one hundred twenty-one point one degrees Celsius for three minutes, ensuring the inactivation of highly heat-resistant Clostridium botulinum spores.

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168. (C) Positive pressure on the pasteurized side
In plate heat exchangers, raw and pasteurized milk flow through alternating channels to exchange heat. To prevent cross-contamination in the event of a plate pinhole leak, the system is designed to maintain higher pressure on the pasteurized side. This positive pressure ensures that any leakage flows from the pasteurized milk into the raw milk, preventing raw contamination.

169. (D) HTST results in less thermal damage than LTLT
High Temperature Short Time pasteurization and Low Temperature Long Time pasteurization both achieve the same level of pathogen destruction. However, because chemical degradation is more sensitive to temperature changes than microbial destruction, the shorter exposure time used in HTST systems results in significantly less thermal

damage to milk proteins, vitamins, and overall sensory quality than LTLT pasteurization.

170. (A) To accommodate thermal expansion during heating
During in-container sterilization, filled bottles are sealed and heated to high temperatures. As the temperature rises, the liquid milk expands in volume. Controlling the headspace in each bottle is essential to provide adequate volume for this thermal expansion, preventing excessive internal pressure buildup that could otherwise rupture or break the sealed containers during retort operations.

171. (B) They offer high energy recovery efficiencies
Indirect ultra-high temperature heating systems pass milk through plate or tubular heat exchangers to transfer thermal energy. A major advantage of this design is its ability to recover heat from hot, pasteurized milk to pre-heat incoming cold raw milk. This regeneration process can recover over ninety percent of the energy, reducing operating costs compared to direct steam heating.

172. (B) To prevent the ingress of unsterile ambient air
Aseptic filling systems must keep sterilized milk free from environmental pathogens during packaging. Maintaining positive pressure with HEPA-filtered sterile air inside the filling chamber creates a continuous outward flow. This airflow prevents unsterile ambient air and airborne microflora from entering the filling zone, ensuring the final packaged product remains commercially sterile throughout its shelf life.

173. (B) 40 to 50 degrees Celsius
When manufacturing recombined milk, rehydrating skim milk powder requires precise temperature control. Water temperatures between forty and fifty degrees Celsius are ideal to optimize powder solubility. This temperature range accelerates the hydration of proteins and lactose without causing thermal denaturation of whey proteins, preventing the formation of insolubility indexes and lumps during mixing.

174. (C) Suspension of cocoa using hydrocolloids
Cocoa powder has a higher density than milk and is insoluble in fluid milk. When manufacturing flavored milk, cocoa particles will quickly settle to the bottom of the bottle, creating an undesirable sediment. Incorporating food-grade hydrocolloids, such as carrageenan, is essential to form a weak gel network that keeps the cocoa particles suspended without altering product pourability.

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175. (A) 3.5 to 4.5
Whey-based beverages are formulated to deliver refreshing, slightly tart sensory characteristics. Acidifying these beverages to a pH range of three point five to four point five stabilizes their flavor profile and inhibits pathogens. This acidic environment is typically achieved by adding organic acids like citric acid, which enhances product shelf life and prevents the sedimentation of heat-sensitive whey proteins.

176. (C) Goat
Goat milk fat globules naturally do not cluster and rise to the surface upon standing. This is because goat milk lacks the specific agglutinin protein, which is responsible for clustering fat globules in cow milk. Consequently, goat milk is considered naturally homogenized, maintaining a uniform distribution of fat throughout the liquid phase without mechanical processing.

177. (B) Cows or buffaloes, or a mixture thereof
Food standards and dairy regulations provide strict definitions for milk labeling. Unless specified with a prefix, the term “milk” refers to the normal mammary secretion obtained from cows, buffaloes, or a combination of both. It must be free from colostrum, and no ingredients can be added or extracted to ensure the product remains unadulterated.

178. (B) 1.3440 to 1.3480
The refractive index of cow milk is a constant physical property used to assess its quality and purity. Measured at twenty degrees Celsius, normal cow milk typically falls within the range of one point three four four zero to one point three four eight zero. Deviations from this standard range can indicate dilution with water or other adulterants.

179. (A) Urban consumers via direct marketing channels
The Anand Pattern cooperative model revolutionized the Indian dairy sector by establishing a direct link between rural milk producers and urban consumers. By removing exploitative middlemen, this model ensured that

smallholder farmers received a fair, consistent price for their milk, while providing urban areas with a reliable supply of safe, processed dairy products.

180. (C) Scientific breeding and superior feeding
The National Dairy Plan was launched as a strategic initiative to boost milk production in India. It focused on improving animal genetics through scientific breeding programs, such as artificial insemination with high-quality semen. Additionally, the plan emphasized superior feeding strategies, including balanced ration programs, to enhance the productivity and milk yield of dairy cattle.

181. (A) Dilute sodium hypochlorite
Maintaining hygiene during milking is critical to prevent the spread of mastitis pathogens between cows. Dilute sodium hypochlorite is a highly effective, widely used sanitizer for disinfecting milking machine clusters between milkings. This chlorine-based sanitizer rapidly destroys a broad spectrum of bacteria on contact surfaces, reducing cross-contamination risks and ensuring the production of clean raw milk.

182. (D) Milking sessions they can cool in a given time
Bulk Milk Coolers are graded by their cooling capacity, which is classified based on the number of milking sessions they can handle. This classification determines how quickly and effectively the cooler can reduce the temperature of incoming milk from successive milkings, ensuring that the warm milk from a new session is cooled rapidly without warm-blend temperature spikes.

183. (B) Corrected Lactometer Reading
The Richmond formula is a standard calculation used to estimate the total solids content in milk. In this equation, CLR stands for Corrected Lactometer Reading, which measures milk density. This reading is taken using a lactometer and is adjusted for temperature variations, allowing processors to calculate the total solids content when the fat percentage is also known.

184. (C) Feed flavors, rancidity, and sourness
Organoleptic evaluation remains a primary platform test at dairy receiving docks due to its speed and sensitivity. Trained personnel can instantly detect common sensory defects in raw milk, such as feed flavors, rancidity, and developed sourness. Identifying these off-flavors allows processors to segregate low-quality milk before it is mixed with bulk storage tanks.

185. (D) Vanaspati fat with sesame oil
The Baudouin test is a colorimetric assay used to detect the adulteration of pure ghee or butter with hydrogenated vegetable oil, commonly known as Vanaspati. Under food safety laws, Vanaspati must contain a small percentage of sesame oil. The Baudouin test detects the presence of sesamol in this oil, yielding a distinct pink-to-red color reaction.

186. (A) Organochlorines
Organochlorine pesticides are highly persistent environmental contaminants. Due to their chemical stability and fat-soluble nature, these compounds bioaccumulate in agricultural environments and transfer into animal feed. When dairy cows ingest contaminated feed, the residues accumulate in body fat and are excreted in milk fat, necessitating strict, regular monitoring to protect public health.

187. (B) Ambient temperatures
The lactoperoxidase system is a natural antibacterial system in milk that can be activated to inhibit bacterial spoilage. It is particularly effective at ambient temperatures, making it a valuable tool in areas where mechanical refrigeration is unavailable. Activating this system preserves raw milk quality for several hours during transport, preventing bacterial replication under warm conditions.

188. (B) Mastitis infection in the herd
Somatic cells in milk consist primarily of white blood cells and epithelial cells. A high somatic cell count is a primary indicator of mastitis, an inflammatory infection of the mammary gland in dairy cows. Centrifugal clarifiers can physically remove these cells to improve milk appearance, but a high initial count indicates compromised herd health and reduced milk quality.

189. (A) Bacteria and endospores
Microfiltration is a pressure-driven membrane separation process used in milk processing. It uses membrane pore sizes that allow soluble whey proteins, lactose, and minerals to pass through, while physically retaining larger particles. This makes microfiltration highly effective for

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removing bacteria and bacterial endospores from skim milk, significantly reducing its microbial load without using high-heat treatments.

190. (C) Drops below the fluid's vapor pressure, forming collapsing bubbles
Cavitation is a key physical force that occurs during high-pressure homogenization. As milk passes through the narrow gap of the homogenizing valve, its velocity increases, causing a sharp drop in static pressure. When this pressure drops below the milk's vapor pressure, vapor bubbles form and then violently collapse, generating intense shockwaves that disrupt and reduce fat globule sizes.

191. (D) Air is entrained in milk entering the pump
The operating efficiency of a high-pressure homogenizer decreases significantly if air is entrained in the incoming milk. Because air is highly compressible, its presence inside the homogenizer pump dampens the pressure drops and cavitation forces generated within the valve. This compression dampens the mechanical forces required to break down fat globules, leading to poor homogenization efficiency.

192. (B) 10 degrees Celsius
The Z-value represents the temperature change required to alter the D-value of a specific microorganism by a factor of ten. For calculating thermal process lethality, the standard Z-value for destroying Clostridium botulinum spores in low-acid foods is widely accepted as ten degrees Celsius. This parameter is critical for designing safe thermal pasteurization and sterilization processes.

193. (B) The flow diversion valve directing under-heated milk
In a high-temperature short-time pasteurizer, milk must be held at the target temperature for a specific duration. The holding tube ensures this residence time is met. Immediately following the holding tube, a flow diversion valve monitors the milk's temperature. If the milk is under-heated, this valve automatically diverts it back to the raw milk balance tank for reprocessing.

194. (D) Phosphatase test
The alkaline phosphatase test is a standard regulatory assay used to verify the adequacy of milk pasteurization. Because this natural enzyme is slightly more heat-resistant than the pathogens targeted during pasteurization, its complete inactivation indicates a successful heat treatment. Consequently, detecting active alkaline phosphatase in pasteurized milk indicates either inadequate heating or contamination with raw milk.

195. (A) Nutritional profile and sensory qualities
In-bottle sterilization provides excellent microbiological stability and a long shelf life. However, because this batch process requires extended exposure to high sterilization temperatures, it causes significant thermal damage. This severe heat treatment denatures whey proteins, degrades heat-sensitive vitamins, and promotes Maillard browning, which imparts a cooked, caramelized flavor and darkens the color of the milk.

196. (C) Spraying milk into a chamber filled with steam
Direct steam infusion is an ultra-high temperature heating method where milk is sprayed into a pressurized, steam-filled chamber. This process differs from steam injection, where high-pressure steam is injected directly into a pipe of flowing milk. Steam infusion provides rapid, uniform heating with lower shear forces and less risk of localized overheating, reducing protein fouling on the chamber walls.

197. (A) Aluminum foil layer
Multilayer aseptic cartons are engineered to protect ultra-high temperature processed milk from environmental degradation. Within this structure, a thin layer of aluminum foil serves as an absolute barrier. It blocks the transmission of light, oxygen, and external odors, preventing lipid oxidation and vitamin degradation, which extends the shelf life of the milk without requiring refrigeration.

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198. (D) Fat and SNF content
Standardized milk is a commercial fluid product whose composition has been adjusted to meet specific regulatory standards. This process involves altering the milk fat and solids-not-fat content to precise levels, typically by blending skim milk or cream into the raw milk. Standardizing these ratios ensures consistent nutritional quality and uniformity for consumers, regardless of seasonal variations.

199. (B) Increasing viscosity to retard particle settling
Stabilizers like sodium alginate are added to flavored milks to maintain physical uniformity. These hydrocolloids increase the viscosity of the liquid, creating a weak network that retards the settling of heavy, insoluble particles like cocoa powder. This thickening action keeps the flavoring particles suspended, preventing phase separation and sediment formation during storage without making the milk overly thick.

200. (C) Antimicrobial and immunomodulatory properties
Lactoferrin is an iron-binding glycoprotein naturally found in milk that is prized as a bio-active ingredient in fortified dairy products. It exhibits strong antimicrobial properties by sequestering iron, which is essential for the growth of pathogenic bacteria. Additionally, lactoferrin supports immune function and exhibits anti-inflammatory activities, enhancing the health benefits of fortified liquid milks.

201. (D) Camel
Camel milk contains unique immunological and biochemical properties. It is particularly rich in protective proteins, including a significantly higher concentration of lysozyme than cow or buffalo milk. Lysozyme acts as a natural antimicrobial agent by hydrolyzing the cell walls of Gram-positive bacteria, which helps inhibit bacterial spoilage and extends the raw milk's shelf life.

202. (A) Healthy and free from transmissible diseases
Regulatory guidelines dictate that raw milk intended for processing or direct human consumption must originate from healthy animals. The herd must be free from zoonotic diseases, such as tuberculosis and brucellosis, which can be transmitted to humans through milk. Ensuring the health of dairy cattle is the primary step in protecting food safety and raw milk quality.

203. (A) Water is added or the fat content is increased
The specific gravity of milk is determined by the ratio of its components. Milk fat has a lower density than water, while solids-not-fat, such as proteins and lactose, are denser than water. Therefore, adding water to milk or increasing its fat content will decrease its overall specific gravity, providing a key indicator for detecting water dilution during quality testing.

204. (C) 24%
India is the largest producer of milk globally, contributing approximately twenty-four percent of total world milk production. This leading position is driven by a massive bovine population and the success of the cooperative-led White Revolution. The country's dairy sector relies on millions of smallholder farmers, making milk a key driver of rural livelihoods and national nutrition.

205. (A) Volume, fat, SNF, and daily payment value
Dairy cooperatives operating under the Anand Pattern maintain transparency with their members through systematic record-keeping. Each farmer is issued a passbook to record daily transactions. This book documents the volume of milk delivered, its fat and solids-not-fat percentages, and the calculated financial value of each delivery, ensuring fair payment based on composition and quality.

206. (C) Feeding cattle mold-free grains and silage
Aflatoxin M_1 is a highly carcinogenic contaminant in milk. It is a metabolite of aflatoxin B_1, which is produced by molds on poorly stored cattle feed. To minimize this food safety risk, dairy farms must implement strict feed management practices. Ensuring that cattle are fed only mold-free grains and silage prevents the ingestion of these toxins, eliminating residue transfer into the milk.

207. (D) Adulterated or non-food liquids
Insulated dairy tankers are dedicated exclusively to transporting edible food products to prevent chemical contamination. Transporting adulterated liquids, industrial chemicals, or non-food substances in these vessels is strictly prohibited. Even after thorough cleaning, residues can persist in the tank walls, valves, or hoses, posing severe food safety and chemical hazards if subsequent batches of milk are loaded.

208. (C) Valuing fat and SNF independently
The two-axis pricing policy is a fair payment system used by dairy cooperatives. This system values both milk fat and solids-not-fat independently, ensuring that farmers are compensated for the full nutritional value of their milk. This dual-valuation prevents the unfair practice of pricing milk solely on fat content, which would disadvantage cow milk producers compared to buffalo milk producers.

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209. (B) High acidity or abnormal mineral balance
The alcohol test is a rapid platform test used to assess the thermal stability of raw milk during reception. If a milk sample coagulates when mixed with a standard ethanol solution, it fails the test. This instability is typically caused by developed acidity from bacterial growth or an abnormal salt and mineral balance, indicating the milk is unsuitable for processing.

210. (D) Rose red
The rosalic acid test is a rapid chemical assay used to detect alkaline neutralizers, such as sodium carbonate or sodium hydroxide, in raw milk. These alkaline substances are added fraudulently to neutralize developed lactic acid. In the presence of these neutralizers, adding rosalic acid indicator causes the milk sample to turn a distinct rose red color.

211. (A) Strict environmental and feed controls
Heavy metals cannot be removed from milk through standard processing techniques like pasteurization or clarification. Consequently, mitigating heavy metal contamination requires strict preventative measures at the farm level. Controlling environmental pollution, monitoring the quality of water supplies, and testing cattle feed for heavy metal residues are the most effective ways to prevent these toxins from entering the milk.

212. (C) It kills psychrotrophs while preserving native enzymes
Thermization is a mild heat treatment preferred for raw milk intended for long-term cheese aging. This process destroys cold-tolerant psychrotrophic bacteria, which produce heat-resistant lipases and proteases that cause off-flavors during ripening. However, the mild heat of thermization preserves the milk's native enzymes and lactic acid bacteria, which are essential for developing the characteristic flavors of cheese.

213. (A) Increase the efficiency of skimming
In centrifugal cream separators, separation efficiency is governed by Stokes' Law, which describes the settling velocity of particles in a fluid. Increasing the rotational speed of the bowl generates a stronger centrifugal force field. This higher force accelerates the separation of lighter fat globules from the denser skim milk, thereby increasing the overall skimming efficiency of the system.

214. (D) Spore-rich sludge
Bactofugation is a specialized centrifugal process designed to remove heavy microorganisms, particularly bacterial endospores, from milk. Because these spores have a higher density than both fluid milk and vegetative cells, they are thrown to the outer walls of the centrifuge bowl. This spore-rich sludge is then continuously or intermittently discharged from the unit, improving the microbiological quality of the milk.

215. (C) Slow enzymatic proteolysis of casein micelles by residual bacterial proteases
Age gelation is a major physical defect that limits the shelf life of ultra-high temperature sterilized milk. It is primarily caused by slow enzymatic proteolysis of casein micelles during storage. Psychrotrophic bacteria present in raw milk produce heat-stable proteases that can survive UHT processing. Over time, these residual enzymes degrade casein, destabilizing the micelle structure and forming a gel.

216. (D) 0.21% to 0.23%
The Clot-on-Boiling test is a rapid platform assay used to assess raw milk stability. When milk is heated to boiling, its proteins destabilize if the acidity is high. Coagulation occurs when developed acidity reaches or exceeds approximately zero point two one to zero point two three percent lactic acid. Failing this test indicates the milk is too sour for processing.

217. (D) Log of D-value versus temperature
A thermal death time curve plotted on a semi-logarithmic graph illustrates the temperature sensitivity of microorganisms. The logarithm of the decimal reduction time, or D-value, is plotted against exposure temperature. This linear relationship allows process engineers to calculate the Z-value, which represents the temperature increase required to reduce the thermal death time by ninety percent.

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218. (A) Chilled water or glycol
In a high-temperature short-time pasteurizer, milk must be rapidly cooled to preserve quality and inhibit bacterial growth. After passing through the regeneration section, the pasteurized milk enters the cooling section. Here, it is cooled to four degrees Celsius or below using circulating chilled water or a food-grade propylene glycol solution as the heat transfer utility.

219. (B) p-Nitrophenyl phosphate
The alkaline phosphatase assay uses a colorimetric method to verify pasteurization. The substrate p-nitrophenyl phosphate is added to the milk sample. Active alkaline phosphatase enzymes in raw or under-pasteurized milk cleave the phosphate group from this substrate, releasing p-nitrophenol. This reaction product turns yellow under alkaline conditions, allowing visual or spectrophotometric assessment of the pasteurization process.

220. (B) Disulfide and hydrogen bonds
Whey proteins, such as beta-lactoglobulin and alpha-lactalbumin, are globular proteins stabilized by folding. High temperatures disrupt this structure, causing the proteins to unfold. This denaturation is driven by the breakage of heat-sensitive hydrogen bonds and the rearrangement of disulfide linkages, exposing reactive sulfhydryl groups that can interact with other milk proteins like kappa-casein.

221. (A) Pre-holding at 90 degrees Celsius to stabilize proteins
Protein fouling in UHT heat exchangers can be reduced by stabilizing heat-sensitive proteins before sterilization. Implementing a pre-holding step, typically at ninety degrees Celsius, denatures whey proteins like beta-lactoglobulin. This pre-treatment causes the denatured proteins to interact with casein micelles in a controlled manner, preventing them from depositing and baking onto heat exchanger surfaces.

222. (C) 30% to 35%
In aseptic packaging operations, hydrogen peroxide is used to sterilize packaging materials. To ensure rapid and effective destruction of bacterial endospores, the concentration of the peroxide bath must be maintained between thirty and thirty-five percent. When combined with heat, this concentration generates highly reactive oxygen species that quickly sterilize packaging surfaces before filling.

223. (D) Oxidized anhydrous milk fat
Recombined milk requires blending reconstituted milk solids with milk fat. If the anhydrous milk fat or butter oil used has undergone lipid oxidation, it will impart strong off-flavors to the final product. Oxidized fat contains volatile compounds like aldehydes and ketones, which produce a distinct metallic, cardboard, or rancid taste that compromises the quality of the milk.

224. (C) Rotary retort sterilizer
Sterilized flavored milk beverages packaged in glass bottles are typically sterilized using an in-container thermal process. Glass bottles are loaded into a rotary retort sterilizer, where they are heated with steam or pressurized hot water. The continuous rotation of the retort agitates the milk inside the bottles, accelerating heat transfer and preventing product browning or sedimentation.

225. (B) Probiotic beverage
Probiotics are defined as live microorganisms that, when administered in adequate amounts, confer a health benefit on the host. Fortifying a dairy beverage with live Bifidobacterium species introduces beneficial bacteria that survive transit through the gastrointestinal tract. This supplementation helps balance gut microflora and supports digestive health, classifying the product as a probiotic functional beverage.

226. (D) Mammary secretion without any addition or extraction
International food standards protect the term “milk” by defining it strictly as a natural product. Under these definitions, milk must be the normal mammary secretion obtained from one or more milkings of dairy animals. It must be free from colostrum, and no ingredients may be added or extracted, ensuring consumers receive an unadulterated product.

227. (A) Lactose and chlorides
The freezing point of milk is a highly stable physiological parameter, typically averaging around minus zero point five four zero degrees Celsius. This value is determined by the osmotic pressure of milk, which is maintained in equilibrium with blood. Soluble constituents, specifically lactose and chloride ions in the serum phase, are the primary compounds responsible for maintaining this osmotic balance.

228. (C) The sale of gifted skimmed milk powder and butter oil
Operation Flood was initially financed through international aid and commodity monetization. The World Food Programme gifted skimmed milk powder and anhydrous milk fat to India. These commodities were recombined and sold in

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urban markets, generating the capital required to establish local dairy cooperatives, build processing infrastructure, and support rural milk producers across the country.

229. (A) End-to-end sanitary practices from cow to cooling

Clean milk production is a comprehensive management approach designed to minimize contamination from the farm to the processing plant. It involves implementing sanitary practices during herd management, maintaining clean milking environments, disinfecting equipment, and rapidly cooling harvested milk. These preventative measures protect milk safety, reduce initial bacterial loads, and extend the shelf life of dairy products.

230. (D) Bacterial lactic acid production during poor storage

High titratable acidity in raw milk at a receiving dock indicates quality degradation. Freshly drawn milk exhibits a low, natural acidity. If acidity is elevated upon reception, it is typically due to bacterial contamination and growth. Under unhygienic conditions or warm storage, lactic acid bacteria multiply and ferment lactose into lactic acid, souring the milk.

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CHAPTER 02

Indigenous Milk Products and Technological Advances in Traditional Dairy Products

2003

1. Which fundamental physico-chemical property primarily dictates the superior suitability of buffalo milk over cow milk for manufacturing heat-desiccated products like Khoa?
(A) Higher total solids and larger fat globule size
(B) Higher whey protein nitrogen index
(C) Lower concentration of colloidal calcium phosphate
(D) Smaller casein micelle diameter

2011

2. Directions: In the following question, a statement of Assertion (A) is followed by a statement of Reason (R). Choose the correct option.
Assertion (A): Buffalo milk requires a lower coagulation temperature than cow milk for Paneer manufacturing.
Reason (R): Buffalo milk possesses a higher buffering capacity and greater micellar casein concentration.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2019

3. Which of the following is NOT a characteristic difference between cow and buffalo milk affecting technological processing?
(A) Cow milk has a higher proportion of saturated fatty acids.
(B) Buffalo milk contains a higher concentration of calcium.
(C) Buffalo milk displays a faster enzymatic rennet clotting time.
(D) Cow milk exhibits a significantly lower inherent pH value.

2019

4. Consider the following statements regarding the physico-chemical differences between cow and buffalo milk:
I. Carotene is entirely absent in buffalo milk fat.
II. Buffalo milk has lower viscosity than cow milk.
III. The heat stability of buffalo milk is generally lower than that of cow milk.
Which of the above statements are correct?
(A) I only
(B) II and III
(C) II only
(D) I and III

2001

5. Based on the higher biliverdin content in buffalo milk, what sensory outcome is reliably inferred when comparing it directly to cow milk products?
(A) A deeper, more intense yellow hue in formulated butter
(B) A distinctly greenish-white tint in resultant Chhana
(C) A pronounced, rich cooked flavor upon pasteurization
(D) A softer, highly spreadable fat texture in the product

2021

6. Match the milk property in List I with its specific impact on traditional products in List II.
List I: (Milk property)
P. Higher fat percentage
Q. Absence of beta-carotene
R. Higher calcium and phosphorus
S. Larger casein micelles
List II: (Impact on traditional products)
1. Whiter color of Khoa
2. Firmer Paneer texture
3. Higher yield of Rabri
4. Slower acid development in Dahi

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(A) P-2, Q-3, R-4, S-1
(B) P-3, Q-1, R-2, S-4
(C) P-1, Q-4, R-3, S-2
(D) P-4, Q-2, R-1, S-3

2024

7. Identify the correct pair representing a milk component and its functional role in indigenous dairy processing.
(A) Lactose – Functions as the primary structural emulsifier in Paneer
(B) Whey proteins – Form the primary structural crosslinked network in Chhana
(C) Milk fat – Decreases the overall yield of traditional Shrikhand
(D) Casein micelles – Drive the textural firmness in heat-desiccated Khoa

2006

8. In comparison to cow milk, buffalo milk behaves differently during traditional thermal processing. Which of the following best describes this comparison?
(A) Buffalo milk exhibits greater susceptibility to heat-induced browning.
(B) Buffalo milk forms a softer coagulum upon acidification.
(C) Buffalo milk undergoes browning reactions at a significantly slower rate.
(D) Buffalo milk requires lower homogenization pressures.

2016

9. What is the primary technological advantage of blending cow and buffalo milk for specific traditional dairy product manufacturing?
(A) Complete elimination of heat-resistant pathogenic microflora during standard pasteurization
(B) Optimization of textural firmness and moisture retention in coagulated products
(C) Drastic reduction in the total duration required for heat desiccation steps
(D) Spontaneous, rapid lactic fermentation without the addition of starter cultures

2012

10. Which mineral is significantly more abundant in buffalo milk compared to cow milk, critically influencing micelle stability?
(A) Iron
(B) Calcium
(C) Copper
(D) Zinc

2014

11. Which factor represents the most critical market dynamic driving the commercial scale-up of traditional Indian dairy products?
(A) Increasing consumer demand for packaged, ready-to-eat ethnic sweets
(B) Continuous, significant decline in domestic fluid milk consumption
(C) Stagnant or declining urbanization rates in major metropolitan areas
(D) Complete eradication of all decentralized, unorganized sector players

2012

12. What is the direct economic effect of transitioning traditional dairy product manufacturing from the unorganized sector to organized commercial scaling?
(A) Reduction in overall milk procurement prices across all regions
(B) Complete elimination of value-added tax liabilities and duties
(C) Enhanced standardization and export market penetration
(D) Decreased or highly variable product shelf-life in retail stores

2014

13. Consider the following statements regarding the commercial scale of the Indian traditional dairy sector:
I. The organized sector holds a monopoly over Khoa production.
II. Traditional dairy products consume over 50% of total milk produced in India.
III. Profit margins on ethnic sweets are generally lower than on liquid milk.
IV. Mechanization has completely replaced manual halwai operations nationwide.
Which of the above statements are INCORRECT?
(A) I, III and IV
(B) II and III
(C) I, II and IV
(D) III and IV

2006

14. Identify the INCORRECT statement concerning the market dynamics of traditional dairy products.
(A) Shelf-life limitations historically restricted export potential.
(B) Mechanization is bridging the gap between traditional demand and industrial supply.
(C) The unorganized sector currently accounts for zero percent of indigenous milk sweets.

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(D) Value addition in indigenous dairy products yields significant economic returns.

2002

15. Which of the following is NOT a primary driver for the industrialization of traditional dairy products?
(A) Growing necessity for maintaining consistent product quality
(B) Retrospective desire to lower the nutritional value of milk
(C) Compliance with stringent national food safety regulations
(D) Achievement of significant, long-term economies of scale

2012

16. Under economic contribution frameworks, traditional dairy products are primarily classified as:
(A) By-products of butter manufacturing
(B) Subsistence agricultural outputs
(C) Low-margin fluid commodities
(D) High-value added dairy products

2011

17. Directions: In the following question, a statement of Assertion (A) is followed by a statement of Reason (R). Choose the correct option.
Assertion (A): The commercial manufacturing of indigenous dairy products has seen rapid growth in recent decades.
Reason (R): The unorganized halwai sector can no longer meet the hygiene and volume demands of urban populations.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2003

18. How is the "organized sector" defined within the context of the Indian dairy industry's market dynamics?
(A) Independent rural agricultural households producing raw milk solely for domestic self-consumption
(B) Unregulated street vendors and local middlemen selling raw, unpackaged liquid milk in urban areas
(C) Regulated industrial entities operating under standardized processing and legal safety frameworks
(D) Cooperative primary dairy societies exclusively focused on producing and distributing fluid milk

2023

19. Identify the INCORRECT pair regarding market segmentation of Indian dairy products.
(A) Traditional milk sweets – Low volume, low margin
(B) Liquid milk products – High volume, low margin
(C) Milk powders and ingredients – Commodity market
(D) Probiotic Dahi products – Functional food segment

2014

20. Approximately what percentage of total milk produced in India is converted into traditional dairy products?
(A) 5-10%
(B) 15-20%
(C) 25-30%
(D) 50-55%

2004

21. Arrange the following traditional dairy products in the correct sequence from lowest to highest moisture content:
I. Chhana
II. Khoa (Pindi)
III. Rabri
IV. Ghee
(A) IV, II, I, III
(B) IV, I, II, III
(C) II, I, III, IV
(D) I, II, III, IV

NODIA

2021

22. Which traditional Indian dairy product is primarily classified under the "fat-rich" category?
(A) Shrikhand
(B) Kalakand
(C) Malai
(D) Rasgulla

2016

23. Which of the following is NOT classified as a heat-desiccated traditional dairy product?
(A) Basundi
(B) Rabri
(C) Kheer
(D) Sandesh

2008

24. Match the traditional dairy product in List I with its primary manufacturing principle in List II.

List I: (Traditional dairy product)

P. Paneer
Q. Lassi
R. Peda
S. Makhan

List II: (Primary manufacturing principle)

1. Heat-desiccation
2. Acid-coagulation
3. Fermentation
4. Fat-concentration

(A) P-2, Q-3, R-4, S-1
(B) P-3, Q-1, R-4, S-2
(C) P-2, Q-3, R-1, S-4
(D) P-4, Q-2, R-2, S-1

2025

25. An artisan wishes to formulate a product that relies simultaneously on controlled lactic acid production and subsequent moisture removal. Which product classification framework applies?
(A) Direct acid-coagulated
(B) Fermented and concentrated
(C) Heat-desiccated only
(D) Fat-rich only

2022

26. Consider the following statements concerning the classification of Indian dairy products:
I. Dahi is classified as an unfermented milk beverage.
II. Khoa is a heat-desiccated base for Barfi.
III. Chhana is an acid-coagulated base for Rasgulla.
IV. Shrikhand is classified as a heat-desiccated sweet.
V. Ghee is classified as a fat-rich dairy product.
Which of the above statements are correct?
(A) II, III and V
(B) I, II, III and V
(C) II, III, IV and V
(D) III, IV and V

2025

27. Identify the correct statement regarding the classification of Kalakand.
(A) It is a partially heat-desiccated and partially acid-coagulated product.
(B) It is a purely acid-coagulated product manufactured with no heat application.
(C) It is a fermented beverage similar to traditional buttermilk or lassi.
(D) It is a strictly fat-rich product manufactured by churning dairy cream.

2011

28. What dictates the firm, sliceable structure of Paneer compared to the soft, kneadable structure of Chhana, leading to their distinct sub-classifications?
(A) Higher concentration of milk fat inherently retained in the Chhana matrix
(B) Extensive use of commercial rennet during initial Paneer coagulation steps
(C) Application of mechanical pressure to the coagulum in Paneer
(D) Complete absence of whey components within the final Chhana structure

2009

29. Compare Rabri and Basundi based on their classification framework.
(A) Rabri is fermented using lactic cultures, while Basundi is heat-desiccated using open pans.
(B) Rabri is acid-coagulated using citric acid, while Basundi is a fat-rich emulsion with stabilizers.
(C) Both are fat-rich products completely devoid of lactose due to extensive enzymatic breakdown.
(D) Both are heat-desiccated, but Rabri contains distinct flaky layers of clotted cream.

2025

30. Which of the following falls strictly under the "acid-coagulated" classification without subsequent intense heat desiccation?
(A) Fried Gulab Jamun
(B) Desiccated Milk Cake
(C) Rasgulla (raw base)
(D) Slow-cooked Kheer

2005

31. According to FSSAI standards, what is the minimum milk fat requirement (on dry matter basis) for Khoa prepared from cow milk?
(A) 10%
(B) 20%
(C) 30%
(D) 40%

2023

32. Directions: In the following question, a statement of Assertion (A) is followed by a statement of Reason (R). Choose the correct option.
Assertion (A): Danedar Khoa requires a minor addition of a coagulant during its manufacturing

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process.
Reason (R): The coagulant induces complete whey separation similar to Chhana production.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2003
33. Consider the following statements regarding the types of Khoa and their distinct compositions:
I. Pindi Khoa has the highest moisture content among all Khoa variants.
II. Dhap Khoa is primarily utilized for manufacturing Gulab Jamun.
III. Danedar Khoa is characterized by a smooth, homogenous texture.
Which of the above statements are INCORRECT?
(A) I and II
(B) I and III
(C) II only
(D) I only

2002
34. How is "Rabri" formally defined concerning its compositional structure?
(A) A clear, concentrated milk serum completely devoid of active casein and whey proteins
(B) A fermented, refreshing whey beverage flavored with spices and sweetened with jaggery
(C) A sweetened, heat-desiccated dairy product containing layers of clotted cream (malai)
(D) A highly coagulated solid milk block pressed under heavy weights to remove all moisture

2011
35. Which of the following parameters is NOT typically mandated by FSSAI for grading heat-desiccated traditional products like Basundi?
(A) Specific gravity of the whey
(B) Total solids content
(C) Added sugar limits
(D) Total titratable acidity

2018
36. Consider the following steps involved in grading a batch of commercial Khoa for FSSAI compliance:
I. Moisture content analysis
II. Sensory evaluation for stale-ness
III. Fat on dry matter (FDM) determination
IV. Sampling representing the entire batch
What is the correct sequence of these steps?
(A) IV, II, I, III
(B) II, I, III, IV
(C) IV, I, III, II
(D) I, III, II, IV

2010
37. If a batch of Khoa displays an abnormally high moisture content exceeding FSSAI limits, what can be logically inferred about its shelf life?
(A) It will exhibit extremely high physical resistance to oxidative rancidity.
(B) It will be highly susceptible to rapid fungal and bacterial spoilage.
(C) It will undergo an immediate, spontaneous auto-fermentation into Dahi.
(D) It will have a highly prolonged, virtually indefinite storage shelf life.

2007
38. Identify the correct pair mapping a heat-desiccated product to its typical total solids concentration.
(A) Khoa (Pindi) – 30-35% TS
(B) Rabri – 10-15% TS
(C) Basundi – 40-45% TS
(D) Dhap Khoa – 80-85% TS

2025
39. Which grading parameter is the least relevant when purely assessing the chemical compositional legality of Khoa under FSSAI standards?
(A) Moisture percentage
(B) Milk fat on dry matter
(C) Starch adulteration test
(D) Exact packaging artwork color

2013
40. In a compositional comparison between Rabri and Basundi, which attribute distinctly differentiates them despite both being sweetened, partially desiccated products?
(A) Rabri has a heterogeneous texture with malai flakes, whereas Basundi is largely homogenous.
(B) Basundi has zero fat content because it is manufactured from highly skimmed dairy permeates.
(C) Rabri contains added thermophilic lactic acid starter cultures to initiate fermentation.
(D) Basundi is exclusively manufactured from highly pasteurized, non-fat reconstituted skim milk.

2003
41. According to FSSAI, the maximum permissible moisture content in Paneer is:

NODIA

(A) 50%
(B) 60%
(C) 70%
(D) 80%

2025

42. Match the acid-coagulated base product in List I with its corresponding FSSAI fat requirement on dry matter in List II.

List I: (Acid-coagulated base product)
P. Standard Paneer
Q. Low-fat Paneer
R. Standard Chhana (Cow)
S. Standard Chhana (Buffalo)

List II: (FSSAI fat requirement on dry matter)
1. Not less than 50%
2. Less than 15%
3. Not less than 40%
4. Not less than 50% (often legally identical to standard paneer limit depending on variant)

(A) P-1, Q-2, R-3, S-4
(B) P-2, Q-1, R-4, S-3
(C) P-3, Q-4, R-1, S-2
(D) P-4, Q-3, R-2, S-1

2019

43. Identify the INCORRECT statement regarding the grading of Chhana.
(A) FSSAI mandates a minimum of 75% moisture for standard Chhana.
(B) High-quality Chhana should have a soft, uniform, and spongy texture.
(C) Sourness or acidic flavor is considered a severe defect in fresh Chhana.
(D) Good quality cow milk Chhana exhibits a pale yellowish color.

2007

44. Consider the following statements concerning the compositional standards of Paneer and Chhana:
I. Paneer has a lower moisture content than Chhana.
II. Chhana is subjected to mechanical pressing to meet its legal standards.
III. FSSAI permits the addition of specific firming agents in Paneer.
IV. Both products must be free from added starches and non-dairy fats.

Which of the above statements are correct?
(A) I, II and IV
(B) II and III
(C) I, II and III
(D) I and IV

2006

45. Which of the following best explains why buffalo milk Paneer is preferred commercially over cow milk Paneer?
(A) It has a significantly lower fat content.
(B) It requires double the amount of coagulant.
(C) It inherently contains higher lactose levels preventing browning.
(D) It exhibits a tighter, firmer body and whiter appearance.

2017

46. An inspector finds a batch of commercial Paneer with a moisture content of 65% and FDM of 45%. What regulatory action applies?
(A) It is legally classified as premium-grade export quality Paneer.
(B) It is perfectly compliant with standard FSSAI chemical regulations.
(C) It fails FSSAI standard requirements for both moisture and fat.
(D) It is legally re-classified as moisture-compliant standard Chhana.

2023

47. Directions: In the following question, a statement of Assertion (A) is followed by a statement of Reason (R). Choose the correct option.

Assertion (A): Chhana intended for Rasgulla making must possess a very soft and smooth body.

Reason (R): Excessive fat in the milk reduces the moisture-retaining capacity of the protein matrix in Chhana.

(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2014

48. Identify the INCORRECT pair regarding chemical components and their typical percentages in fresh cow milk Chhana.
(A) Moisture – 53-55%
(B) Fat – 23-25%
(C) Protein – 17-18%
(D) Lactose – 15-20%

2013

49. Under FSSAI guidelines, Paneer is technically classified within which broader food regulatory category?
(A) Chhana and related coagulated milk products

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(B) Standardized varieties of hard ripened cheeses
(C) Commercial grades of concentrated milk powders
(D) Fermented pasteurized liquid milk beverages

2012
50. What is the standard coagulant temperature range typically specified for achieving the legal textural grade of Paneer?
(A) 30-40°C
(B) 50-60°C
(C) 70-85°C
(D) 90-100°C

2015
51. Calculate the expected yield of Paneer (approximate) from 100 liters of standardized buffalo milk containing 6% fat and 9% SNF.
(A) 8-10 kg
(B) 14-16 kg
(C) 20-22 kg
(D) 25-28 kg

2003
52. Consider the following statements regarding factors influencing the recovery rates in traditional dairy products:
I. Higher heat treatment of milk decreases the recovery of whey proteins in Paneer.
II. Total solids recovery in Khoa is approximately 99%.
III. Increased fat homogenization drastically lowers the yield of Chhana.
IV. Coagulation at higher pH (above 6.5) maximizes protein recovery in Paneer.
V. The addition of calcium chloride can increase product yield in acid-coagulated products.
Which of the above statements are INCORRECT?
(A) I, II and V
(B) II, IV and V
(C) I, III and V
(D) I, III and IV

2006
53. What is the direct effect of utilizing ultra-high treatment (UHT) treated milk for Paneer manufacturing on product yield?
(A) Decreases overall yield due to complete thermal degradation of lactose isomers
(B) Increases yield by incorporating denatured whey proteins into the casein matrix
(C) Decreases overall yield by physically preventing milk fat globule entrapment
(D) Has absolutely no measurable effect on the total solids recovery of products

2003
54. Consider the following steps to calculate the percentage recovery of fat in Khoa:
I. Determine the weight and fat percentage of the produced Khoa.
II. Calculate the total fat mass in the final Khoa.
III. Calculate the total fat mass in the initial milk.
IV. Divide Khoa fat mass by milk fat mass and multiply by 100.
What is the correct sequence of these steps?
(A) I, III, II, IV
(B) III, I, II, IV
(C) III, II, I, IV
(D) I, II, III, IV

2022
55. Which of the following factors does NOT negatively impact the yield of Chhana during commercial processing?
(A) Use of over-aged, highly acidic milk
(B) Excessive agitation during coagulation
(C) Using highly diluted coagulant solutions
(D) Coagulating the milk at exactly 80°C

2005
56. Match the mathematical yield formulation in List I with its corresponding traditional dairy product context in List II.
List I: (Mathematical yield formulation)
P. $\left(\frac{\text{Total Solid sin Milk}}{\text{Total Solid sin Product}}\right) \times 100$
Q. Recovery of casein + denatured whey proteins + retained fat/moisture
R. Volume reduction factor of 4:1 or 5:1
S. Yield largely dependent on sugar addition and fat content
List II: (Traditional dairy product context)
1. Paneer yield principle
2. Khoa yield efficiency
3. Basundi concentration ratio
4. Sandesh yield estimation
(A) P-4, Q-3, R-2, S-1
(B) P-3, Q-4, R-1, S-2
(C) P-1, Q-2, R-4, S-3
(D) P-2, Q-1, R-3, S-4

2013
57. Identify the correct statement regarding the theoretical yield of Khoa.
(A) Khoa yield is always 50% of the initial milk volume regardless of fat content.
(B) Khoa yield strictly equals the total solids

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of milk plus an average of 30% retained moisture.
(C) Buffalo milk yields less Khoa per liter than cow milk.
(D) The addition of sugar prior to desiccation mathematically decreases the theoretical yield of Khoa.

2013

58. Which variable is mathematically irrelevant when calculating the pure total solids (TS) recovery percentage of Paneer?
(A) Weight of milk used
(B) Ambient humidity in the processing hall
(C) Total solids percentage of the milk
(D) Total solids percentage of the produced Paneer

2014

59. Comparing the yield of Chhana made from cow milk versus buffalo milk, which statement mathematically represents the standard industrial observation?
(A) Buffalo milk yields a higher percentage (approx. 20-22%) due to higher initial TS, whereas cow milk yields approx. 15-17%.
(B) Cow milk yields a much higher percentage (approx. 20-22%) of Chhana, whereas buffalo milk yields a much lower (approx. 10-12%).
(C) Both types of milk yield exactly 15% Chhana under identical pasteurization, coagulation, and mechanical pressing conditions.
(D) Buffalo milk yield is mathematically lower due to excessive, uncontrolled fat globule losses into the remaining whey portion.

2016

60. How is the "recovery rate" formally defined in the context of indigenous dairy product manufacturing?
(A) The physical speed and rate at which liquid milk solidifies under steady, atmospheric open-pan heating conditions
(B) The net financial return on capital investment realized after selling the processed traditional dairy product
(C) The percentage of a specific milk constituent successfully retained in the final product compared to the initial milk
(D) The total volumetric output of secondary whey recovered post-coagulation from the cheese pressing vat system

2007

61. During the intense thermal processing of milk, which whey protein is most susceptible to heat-induced denaturation?
(A) Alpha-lactalbumin
(B) Beta-lactoglobulin
(C) Bovine serum albumin
(D) Immunoglobulins

2007

62. Directions: In the following question, a statement of Assertion (A) is followed by a statement of Reason (R). Choose the correct option.
Assertion (A): The coagulation of milk for Chhana making is achieved at a pH closer to 5.4 rather than the isoelectric point of casein (4.6).
Reason (R): Coagulation at higher pH combined with high heat incorporates denatured whey proteins and yields a softer texture.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2015

63. Consider the following statements concerning casein micelle interactions during processing:
I. Heat treatment disrupts the kappa-casein layer, increasing micelle reactivity.
II. Lowering the pH removes colloidal calcium phosphate from the micelle.
III. Intense cooling irreversibly fuses casein micelles together.
Which of the above statements are correct?
(A) I and III
(B) I and II
(C) II and III
(D) II only

2007

64. If milk is subjected to severe pre-heating before acid coagulation, what can be logically inferred about the resulting whey?
(A) It will contain a highly elevated level of intact beta-lactoglobulin because of incomplete thermal coagulation processes.
(B) It will appear visibly more greenish-yellow due to the extensive chemical degradation of riboflavin and other vitamins.
(C) It will have zero residual lactose content as a result of complete thermal caramelization during pre-heating stages.
(D) It will have a lower protein content due

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to the co-precipitation of denatured whey proteins with micellar casein.

2013

65. Which of the following physicochemical parameters is the least relevant to the rapid acid coagulation kinetics of hot milk?
(A) The naturally occurring dissolved oxygen level in milk
(B) The precise temperature profile of the milk during acid addition
(C) The exact strength and chemical type of the acidulant used
(D) The physical agitation speed maintained during the acid addition

2023

66. Consider the following physico-chemical events during the acid coagulation of milk at 80°C:
I. Neutralization of the negative charge on kappa-casein
II. Addition of the acidulant
III. Aggregation of casein micelles into a visible coagulum
IV. Solubilization of colloidal calcium phosphate
What is the correct sequence of these events?
(A) I, II, IV, III
(B) II, IV, I, III
(C) II, I, IV, III
(D) IV, II, I, III

2018

67. Identify the correct pair mapping a physicochemical process to its technological outcome in traditional products.
(A) Casein micelle aggregation – Formation of a solid coagulum in Chhana
(B) Whey protein denaturation – Decreased overall yield of commercial Paneer
(C) Lactose crystallization – Formation of smooth texture in fresh Rabri base
(D) Fat coalescence – Enhanced chemical shelf life of unpasteurized raw milk

2019

68. What is the primary cause of the "cooked flavor" development during the initial heat desiccation phase of Khoa making?
(A) Complete, rapid thermal caramelization of milk lactose at low temperatures
(B) Auto-oxidation of volatile milk lipids under direct atmospheric exposure
(C) Enzymatic fermentation of galactose by contaminating thermophilic microbes
(D) Release of volatile sulfhydryl (-SH) groups from denatured whey proteins

2022

69. When optimizing the coagulation kinetics for Paneer, an operator notices the coagulum is excessively hard and rubbery. Applying physicochemical principles, what adjustment is required?
(A) Increase the concentration of the citric acid solution
(B) Decrease the temperature of the milk at the time of acid addition
(C) Hold the milk at boiling temperature for a longer duration before coagulation
(D) Rapidly increase the mechanical pressing weight

2005

70. Identify the INCORRECT statement regarding the physicochemical mechanisms of milk processing.
(A) Casein is highly stable to heat compared to whey proteins.
(B) Acidification reduces the electrostatic repulsion between casein micelles.
(C) Calcium bridges play no role in the structural integrity of the Paneer matrix.
(D) Heat-induced interaction occurs between beta-lactoglobulin and kappa-casein.

2013

71. The Maillard reaction in indigenous dairy products is primarily a chemical reaction between:
(A) Hydrolyzed sucrose and simple triglycerides
(B) Free lactose sugars and emulsified milk fat
(C) Insoluble calcium phosphate and lactic acid
(D) Reducing sugars and amino groups of proteins

2009

72. Match the specific reaction in List I with its dominant characteristic in traditional sweets in List II.

List I: (Specific reaction)
P. Maillard browning
Q. Caramelization
R. Lipid oxidation
S. Strecker degradation

List II: (Dominant characteristic in traditional sweets)
1. Requires temperatures generally above 150°C to initiate solely on sugars
2. Reaction between lactose and lysine
3. Contributes complex aroma volatiles during

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advanced browning
4. Causes off-flavors (rancidity) rather than desired browning

(A) P-1, Q-2, R-3, S-4
(B) P-2, Q-1, R-4, S-3
(C) P-3, Q-4, R-1, S-2
(D) P-4, Q-3, R-2, S-1

2011

73. Which manufacturing parameter best controls the extent of Maillard browning in heat-desiccated milk products?
(A) The fat and total protein content of the starting raw milk
(B) The intensity and duration of the thermal processing
(C) The ambient relative humidity inside the main processing room
(D) The specific gravity and viscosity of the initial raw milk

2013

74. Consider the following statements regarding flavor profile development in heat-desiccated sweets:
I. Caramelization occurs extensively at standard milk pasteurization temperatures.
II. Maillard browning strictly requires enzymatic catalysts to proceed.
III. High moisture content inhibits the later stages of Maillard browning.
IV. Diacetyl is the primary flavor compound generated during heat desiccation.
Which of the above statements are INCORRECT?
(A) I, II and III
(B) II, III and IV
(C) I, II and IV
(D) I, III and IV

2018

75. Compare the flavor profiles of Khoa and Chhana based on their primary processing principles.
(A) Khoa possesses rich, nutty, and caramelized notes; Chhana has a bland, slightly acidic, and fresh dairy flavor.
(B) Khoa has a highly acidic and sour profile; Chhana has a highly pronounced, deeply caramelized and sweet flavor.
(C) Both exhibit intense Maillard browning flavor notes due to identical heat exposure during open-pan manufacturing.
(D) Khoa flavor is driven exclusively by lipolysis, whereas Chhana flavor is driven solely by enzymatic proteolysis.

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2012

76. Which of the following is a negative consequence of excessive Maillard browning in traditional milk sweets?
(A) Enhanced and prolonged antioxidant properties
(B) Formation of highly complex flavor aroma compounds
(C) Loss of essential amino acids, particularly lysine
(D) Increased structural resistance to lipid oxidation

2012

77. In the context of intense thermal desiccation, how is caramelization chemically classified?
(A) An oxidative, non-enzymatic thermal degradation of unsaturated lipids
(B) A progressive, proteolytic chemical breakdown of stable micellar casein
(C) An enzymatic browning reaction involving active plant polyphenol oxidase
(D) A non-enzymatic, heat-induced degradation and dehydration of sugars

2002

78. Which of the following critical intermediate compounds are formed during the early stages of the Maillard reaction?
(A) Volatile free fatty acids
(B) Complex lipid polymers
(C) Amadori rearrangement products
(D) Lactic acid enantiomers

2018

79. Identify the INCORRECT pair regarding the flavor profile development in Khoa-based sweets.
(A) Furfurals – Byproducts of sugar dehydration contributing to browning
(B) Melanoidins – Colorless compounds that impart intense sweetness
(C) Lactones – Flavor compounds derived from lipid precursors
(D) Sulfhydryl compounds – Impart initial cooked flavor during heating

2012

80. The distinctive brownish hue of Mathura Peda is intentionally developed by:
(A) Addition of approved artificial caramel coloring agents exclusively
(B) Fermentation using highly specific pigmented bacterial starter strains
(C) Complete and rapid extraction of functional micellar milk proteins
(D) Prolonged thermal desiccation and extensive

Maillard chemical reactions

2014

81. What is the primary advantage of utilizing Scraped Surface Heat Exchangers (SSHE) over conventional Karahi methods for Khoa production?

(A) Prevents burn-on and allows continuous, uniform thermal desiccation

(B) Completely eliminates the practical need for raw milk standardization

(C) Enhances manual organoleptic flavor modulation by the master halwai

(D) Decreases the total milk fat content retained in the final product

2016

82. Consider the following statements concerning the texturization processes for Khoa-based sweets:

I. Barfi requires the addition of sugar to Khoa followed by mild heating and setting.

II. Peda texturization involves intensive kneading and partial desiccation to a firmer body.

III. Kalakand demands the complete homogenization of milk to prevent any granular texture.

IV. The incorporation of particulate ingredients (e.g., nuts) disrupts the continuous Khoa matrix.

V. Granularity in Danedar Khoa is achieved through rapid fat separation.

Which of the above statements are correct?

(A) I, II and V

(B) II, III and IV

(C) I, II and IV

(D) III, IV and V

2019

83. What is the technological effect of adding sugar at the final stage of Khoa desiccation during Barfi manufacturing?

(A) It acts as a humectant, depressing water activity and facilitating a smooth, set texture.

(B) It completely prevents any Maillard browning reactions from occurring during hot stages.

(C) It rapidly increases the overall pH value, directly leading to structural product collapse.

(D) It causes the immediate, complete separation of milk fat from the hydrated protein matrix.

2015

84. How is the "texturization" of traditional dairy sweets broadly defined in an industrial context?

(A) The complete, high-temperature removal of all moisture from the liquid milk base to form a stable dehydrated powder

(B) The direct addition of approved synthetic food colorings and thickeners designed to artificially mimic traditional textures

(C) The prolonged sub-zero freezing of the product to alter its macro-cellular and micro-cellular protein matrix structure

(D) The physical and thermal manipulation of the product matrix to achieve desired organoleptic chewiness, granularity, or smoothness

2022

85. Identify the correct statement regarding the conventional halwai method of Khoa preparation.

(A) It utilizes extremely low heating temperatures (below 60°C) for highly prolonged periods.

(B) It relies on vigorous, continuous manual scraping in a shallow iron pan to prevent scorching.

(C) It requires absolutely no mechanical or manual agitation during the entire initial boiling phase.

(D) It completely and reliably avoids the formation of any cooked flavor notes in the final sweet.

2009

86. In traditional Kalakand manufacturing, what specific ingredient is intentionally added to the boiling milk to achieve its characteristic granular texture?

(A) A large quantity of highly active microbial rennet enzyme

(B) Technical-grade sodium bicarbonate as a buffering agent

(C) A minute amount of alum (phitkari) or citric acid

(D) High concentration of sweet high fructose corn syrup

2015

87. Identify the INCORRECT statement comparing conventional and industrial Khoa manufacturing.

(A) Industrial methods utilize continuous processing equipment with integrated cleaning-in-place.

(B) SSHE technology significantly increases energy efficiency and thermal transfer rates in plants.

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(C) Manual traditional methods pose a much higher risk of post-processing microbiological contamination.
(D) Conventional methods yield products with highly standardized moisture contents batch after batch.

2002

88. When formulating industrial Barfi, an engineer wants to ensure a smooth, non-gritty texture. Which practice should be avoided?
(A) Allowing the rapid, uncontrolled crystallization of lactose
(B) Using highly processed, extremely finely milled cane sugar
(C) Kneading the hot Khoa matrix thoroughly before setting steps
(D) Controlling the gradual, multi-stage cooling rate of the mass

2018

89. Identify the correct pair relating a Khoa-based sweet to its key texturization characteristic.
(A) Kalakand – Extremely smooth, homogeneous, highly elastic, and completely devoid of structural grains
(B) Peda – Firm, kneaded, heavily desiccated structure possessing a smooth to slightly grainy bite
(C) Peda – Granular, dry, distinctly crumbly, and showing signs of extensive oil separation on surfaces
(D) Milk Cake – Soft, spreadable, heavily aerated, and easily poured at room temperature conditions

2012

90. What is the main reason why copper pans were historically favored over stainless steel in conventional Khoa making?
(A) Copper completely and reliably prevents any form of catalytic lipid oxidation.
(B) Copper possesses superior thermal conductivity, reducing localized burning.
(C) Copper naturally imparts a highly desirable metallic off-flavor to traditional sweets.
(D) Copper naturally acidifies the incoming liquid milk, aiding the thermal desiccation.

2007

91. In industrial Paneer manufacturing, what is the standard sequence immediately following the coagulation of milk?
(A) Separation of whey, hooping of the curd, and mechanical pressing
(B) Immediate vacuum packaging of the hot, unseparated curd slurry
(C) Controlled addition of active bacterial starter cultures for fermentation
(D) Intense mechanical churning of the hot coagulum to extract butterfat

NODIA

2003

92. Identify the INCORRECT statement regarding coagulant selection for Chhana and Paneer.
(A) Citric acid is widely used industrially due to its pure flavor profile.
(B) Lactic acid yields a slightly softer coagulum than calcium chloride.
(C) Sour whey is highly preferred in industrial Paneer making for strict standardization.
(D) The concentration of the coagulant directly affects the moisture retention of the curd.

2011

93. A dairy plant observes that its Paneer is consistently too dry and hard. What conceptual application in the temperature optimization process should they implement?
(A) Boil the milk continuously for exactly 30 minutes prior to adding acid
(B) Increase the coagulation temperature to a minimum of 95°C during acid addition
(C) Apply double the standard calibrated mechanical pressing weight on the curd blocks
(D) Decrease the coagulation temperature slightly (e.g., from 85°C to 70°C)

2004

94. Identify the correct pair linking the pressing technique to the resultant product characteristic.
(A) Heavy, prolonged mechanical pressing – Produces soft, high-moisture Chhana variants
(B) No mechanical pressing, gravity draining only – Yields dense, block-type Paneer blocks
(C) Pressing under chilled water – Firm, well-knit Paneer blocks with closed texture
(D) Moderate pressing in perforated hoops – Yields spongy Chhana suitable for Rasgulla sweets

2012

95. What is the cause and effect relationship of dipping pressed Paneer blocks in chilled water (4-6°C) for a few hours?
(A) Causes rapid and continuous moisture loss, directly leading to a harder, highly shelf-

stable cheese.
(B) Cools the product, solidifying fat and compacting the protein matrix to impart firmness and sliceability.
(C) Induces immediate, rapid lactic acid fermentation, producing an intensely sour and sharp flavor profile.
(D) Eliminates all dormant bacterial spores, thereby indefinitely extending the product's stable shelf life.

2010

96. Which of the following is NOT a recommended industrial practice for optimizing Chhana quality?
(A) Using standardized milk with a specific fat to SNF ratio
(B) Slowly adding the coagulant with continuous, gentle agitation
(C) Rapidly cooling the coagulated mass by directly adding chilled water to the vat
(D) Subjecting the coagulum to extreme hydraulic pressure

2025

97. Compare the industrial pressing requirements of Chhana and Paneer.
(A) Paneer requires structural pressing to form cohesive blocks, whereas Chhana only requires whey drainage to form a loose dough.
(B) Chhana requires continuous mechanical pressures exceeding 5 kg/cm^2, whereas standard commercial Paneer requires zero pressure.
(C) Both require identical high-pressure structural pressing systems utilizing automated industrial pneumatic presses.
(D) Chhana pressing is performed exclusively at sub-zero temperatures to completely stop any moisture retention within the curd.

2001

98. How is the "hooping" process defined in Paneer manufacturing?
(A) The continuous, high-temperature open-pan thermal heating of raw milk to initiate structural proteins denaturation
(B) The physical process of skimming and collecting floating milk fat globules directly from the hot milk surface area
(C) The filling of whey-drained curd into specialized metal molds lined with clean muslin cloth to shape the final block
(D) The rapid, high-pressure injection of saturated culinary steam into the vat to directly induce acid coagulation

2004

99. Which of the following is the most common acidulant used in continuous industrial Chhana-making machines?
(A) Hot citric acid solution (1-2%)
(B) Diluted industrial hacking acid
(C) Concentrated organic acetic acid
(D) Reagent-grade organic tartaric acid

2016

100. The optimum pH range for achieving the best textural qualities in industrial Paneer coagulation is:
(A) 4.2 - 4.4
(B) 5.3 - 5.5
(C) 6.0 - 6.2
(D) 6.6 - 6.8

2001

101. Which specific starter culture blend is most appropriate for the commercial manufacturing of traditional sweet Dahi (Mishti Doi)?
(A) Lactococcus lactis subsp. lactis combined with Leuconostoc mesenteroides strains
(B) Streptococcus thermophilus and Lactobacillus delbrueckii subsp. bulgaricus
(C) Propionibacterium freudenreichii subsp. shermanii and related dairy propionibacteria
(D) Penicillium roqueforti mold spores and associated lipolytic ripening enzymes

2006

102. Identify the INCORRECT pair regarding the traditional milk sweet and its base material.
(A) Sandesh – Chhana
(B) Rasgulla – Chhana
(C) Gulab Jamun – Paneer
(D) Shrikhand – Chakka (hung curd)

2025

103. If a commercial batch of Shrikhand exhibits extreme syneresis (whey separation) during retail display, what can be inferred about the manufacturing process?
(A) The intermediate curd base was excessively pressed, thereby physically removing far too much structural moisture.
(B) The starting raw milk was severely over-pasteurized, leading to total denaturing of all available whey proteins.
(C) An excessive, unregulated amount of dry crystalline sugar was added to the finished product during mixing steps.

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(D) Inadequate thermal treatment of milk or insufficient physical removal of whey during the Chakka formation step occurred.

2016

104. Under the technological classification of Indian sweets, Sandesh is classified as:
(A) A Chhana-based, non-fermented, partially desiccated sweet
(B) A traditional heat-desiccated, fat-rich milk dessert
(C) A deep-fried, hot sugar syrup-soaked Khoa sweet product
(D) A frozen, heavily sweetened, fat-rich dairy dessert

2025

105. Which of the following parameters is least relevant when optimizing the continuous industrial production of Rasgulla?
(A) The specific kneading intensity of the Chhana
(B) The addition of active lactic starter cultures to the syrup
(C) The concentration and temperature of the sugar syrup during cooking
(D) The precise fat percentage of the original milk

2007

106. Identify the correct statement regarding the commercial production of Gulab Jamun.
(A) It is exclusively manufactured from 100% pure, unblended cow milk Chhana base without any carbohydrate binders.
(B) The prepared spherical dough balls are deep-fried at controlled oil temperatures before being soaked in hot sugar syrup.
(C) The finished raw dough requires highly intense mechanical pressing under heavy weights prior to the frying stages.
(D) It requires a minimum controlled biological fermentation period of 24 hours using active lactic acid cultures.

2021

107. What is the primary technological advantage of using industrial mechanized kneading systems for Sandesh manufacturing?
(A) It ensures a highly uniform distribution of sugar and a smooth, homogenous texture without manual inconsistencies.
(B) It completely sterilizes the inner core of the sweet product, thereby granting a stable room-temperature shelf life of several years.
(C) It completely removes any technical need for direct thermal heat application or boiling during the entire downstream manufacturing process.
(D) It naturally and continuously introduces beneficial, highly active probiotic lactic acid bacteria directly into the sweet product matrix.

2021

108. In traditional terminology, the intermediate concentrated yogurt base used to manufacture Shrikhand is known as:
(A) Malai
(B) Rabri
(C) Chakka
(D) Matha

2019

109. Identify the INCORRECT statement regarding the boiling of Rasgulla in sugar syrup.
(A) The syrup concentration must be meticulously maintained to prevent the balls from flattening or bursting.
(B) Boiling causes the protein matrix to expand, creating a porous, spongy structure.
(C) During boiling, water evaporates, requiring periodic additions of hot water to maintain syrup consistency.
(D) The process strictly requires a saturated 80° Brix syrup from the very beginning of the boiling phase.

2010

110. A manufacturer wants to produce Dahi with a highly viscous, "set" texture without using artificial stabilizers. What conceptual approach should they apply?
(A) Ferment the standard liquid milk at extremely low temperatures (such as 10°C) to dramatically slow down the initial rate of acid production.
(B) Vigorously and aggressively agitate the warm milk continuously throughout the entire microbiological fermentation and incubation process.
(C) Utilize milk with an elevated total solids content (e.g., by adding skim milk powder) and heat it to 90°C for 10 minutes prior to inoculation.
(D) Dilute the standard incoming liquid milk with 20% pure water to artificially lower the reactive casein and whey protein concentrations.

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2016

111. Identify the correct pair mapping a traditional dairy product to its definitive sensory attribute.
(A) Khoa – Distinctly sour, acidic, and highly effervescent
(B) Rasgulla – Highly spongy, porous, and very syrupy
(C) Paneer – Extremely sweet, highly granular, and brittle
(D) Shrikhand – Very salty, structurally firm, and sliceable

2010

112. What is the cause and effect relationship of a high free fatty acid (FFA) content on the organoleptic quality of traditional milk sweets?
(A) Causes a highly desirable sweet caramel flavor, leading to significantly higher consumer acceptance in markets.
(B) Causes accelerated non-enzymatic oxidative browning, greatly improving the finished product's overall visual appeal.
(C) Causes enhanced, high-density structural protein cross-linking, yielding a much firmer and chewable final texture.
(D) Causes hydrolytic lipid rancidity, directly resulting in distinct soapy, metallic, and bitter off-flavors.

2010

113. Which of the following is NOT a standard instrumental method used to analyze the rheological or textural properties of Indian dairy products?
(A) High-Performance Liquid Chromatography (HPLC)
(B) Texture Profile Analysis (TPA) using a Texture Analyzer
(C) Penetrometry
(D) Dynamic shear rheometry

2004

114. Compare the instrumental texture profile of Paneer and fresh Chhana.
(A) Chhana exhibits higher springiness and cohesiveness values than Paneer.
(B) Both display identical fracture forces under compression testing.
(C) Paneer exhibits higher hardness and chewiness values compared to Chhana.
(D) Paneer behaves as a viscous liquid, while Chhana behaves as a rigid solid.

2012

115. In Texture Profile Analysis (TPA) of traditional dairy products, how is "springiness" defined?
(A) The rate at which a deformed sample returns to its original shape and size after the deforming force is removed
(B) The absolute maximum force required to physically compress the test sample during the very first mastication bite
(C) The total mechanical work and energy required to thoroughly masticate the food sample until it is ready for swallowing
(D) The peak negative force required to physically pull and separate the test probe from the sticky sample surface

2018

116. What is the primary rheological characteristic of a high-quality Shrikhand?
(A) Newtonian fluid behavior with high viscosity and low shear stability
(B) Highly elastic, solid structure with distinct fracture points
(C) Dilatant (shear-thickening) behavior under standard shear stress
(D) Pseudoplastic (shear-thinning) behavior with semi-solid consistency

2024

117. Which standardized scoring system is typically used for the sensory evaluation of indigenous dairy products?
(A) The Scoville heat scale adapted for dairy products
(B) The Brix index measuring total soluble solids content
(C) The 100-point modified ADSA score card system
(D) The pH indicator scale for lactic acid determination

2024

118. Which combination of textural attributes is most desired in premium quality Gulab Jamun?
(A) Hard core, thick, rubbery crust with low moisture retention and dry body
(B) Soft, slightly spongy body, free from central lumps, with uniform syrup absorption
(C) Granular, highly cohesive interior with a heavily crystallized, tough outer crust
(D) Extremely soft, pasty matrix that dissolves instantly in the mouth without chewing

2006

119. Which of the following is an INCORRECT pair regarding textural defects and their instrumental measurement?
(A) Hardness – Measured by the peak force of

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the first compression cycle
(B) Adhesiveness – Measured by the negative work area during probe retraction
(C) Gumminess – Calculated as Hardness × Cohesiveness
(D) Cohesiveness – Measured exclusively by a viscometer

2008
120. If instrumental analysis shows a very low cohesiveness value for a sample of Barfi, which sensory characteristic can be directly inferred?
(A) The Barfi will be crumbly and prone to breaking apart easily in the mouth.
(B) The Barfi will be highly rubbery, elastic, and difficult to bite or chew.
(C) The Barfi will exhibit severe, rapid syneresis with surface whey separation.
(D) The Barfi will have an excessively slimy, sticky, and unpleasant mouthfeel.

2016
121. Under which defect category does "mold growth on the surface of Khoa" fall?
(A) Organoleptic/Flavor defect
(B) Physicochemical defect
(C) Microbiological defect
(D) Rheological defect

2016
122. Which preventive measure is the least relevant for controlling the physicochemical defect of lactose crystallization (sandiness) in condensed milk sweets like Rabri?
(A) Irradiating the product to destroy bacterial spores
(B) Controlling the cooling rate during product processing
(C) Adding micro-seed lactose crystals to induce rapid crystallization
(D) Modulating the final moisture and sucrose concentrations

2016
123. Which of the following statements is correct regarding the defect known as "syneresis" in set Dahi?
(A) It is defined as the formation of gas bubbles and hollow pockets in the curd matrix.
(B) It is primarily caused by an excessively high concentration of milk fat in raw milk.
(C) It is a highly desirable textural trait that indicates proper lactic fermentation.
(D) It refers to the expulsion of whey from the protein network due to physical or thermal shock.

2016
124. What is the main advantage of maintaining strict cold-chain logistics during the storage of fresh Paneer?
(A) It drastically accelerates the enzymatic breakdown of proteins to speed up aging and flavor development.
(B) It prevents the rapid growth of psychrotrophic bacteria and delays the development of sourness.
(C) It causes the complete, uniform crystallization of milk fat to facilitate cleaner block slicing.
(D) It prevents the product matrix from absorbing undesirable volatile external odors during transit.

NODIA

2003
125. The common off-flavor defect described as "oxidized" or "metallic" in fat-rich traditional products is primarily catalyzed by the presence of:
(A) Lactic acid bacteria proliferating during fermentation
(B) Excess lactose undergoing Maillard browning reactions
(C) Copper or iron residues from processing equipment
(D) Whey proteins undergoing thermal denaturation

2002
126. Which of the following statements is INCORRECT concerning defects in Chhana-based sweets?
(A) A "hard core" in Rasgulla often results from insufficient boiling time.
(B) Flattening of Rasgulla can occur if the sugar syrup concentration drops too low during cooking.
(C) Surface browning of Sandesh during storage is a sign of continuing Maillard reactions.
(D) A spongy texture is considered a severe structural defect in Rasgulla.

2002
127. Which intervention is required if Khoa rapidly develops a sour odor and slimy surface within 48 hours?
(A) Implement strict hygiene and packaging to prevent post-process contamination
(B) Increase the fat content of the raw milk to alter the fat-to-protein ratio
(C) Add high concentrations of sugar to the raw

milk before thermal heating
(D) Decrease the desiccation temperature to prevent thermal protein damage

2004
128. Which of the following represents a correct pair of a product defect and its standard preventive measure?
(A) Rancidity in Ghee – Packaging product in highly oxygen-permeable container materials
(B) Spoilage by yeast and molds in Shrikhand – Addition of permitted sorbic acid preservative
(C) Sandiness in Basundi – Storing the finished product at highly fluctuating temperatures
(D) Stale flavor in Khoa – Prolonging the product storage period at warm room temperatures

2017
129. What is the effect of utilizing over-acidified (sour) milk for manufacturing Khoa?
(A) Causes enhanced sweetness that masks high lactic acidity in the mix
(B) Causes premature protein coagulation during heating, leading to a gritty texture
(C) Causes the complete and absolute inhibition of Maillard browning reactions
(D) Causes a substantial increase in the total yield and solid content of Khoa

2004
130. Which of the following is NOT a recognized organoleptic defect in traditional Indian dairy products?
(A) Homogenous, smooth melt-in-mouth texture
(B) Highly intense smokey or burnt flavor
(C) Excessive cooked flavor due to over-heating
(D) Distinctly sour, yeasty, or fruity odor

2022
131. How do Vacuum Packaging and Modified Atmosphere Packaging (MAP) compare for extending the shelf life of Paneer?
(A) MAP creates a hard, dense texture, while vacuum packaging preserves the delicate spongy structure of the product.
(B) Vacuum packaging relies on extreme thermal heating, whereas MAP utilizes ultra-low freezing temperatures.
(C) Vacuum packaging completely removes air, whereas MAP replaces it with gas mixtures to preserve structure.
(D) Both methods physically squeeze the product blocks under high pneumatic pressure to expel excess moisture.

2013
132. How is "Active Packaging" defined in the context of food technology for dairy products?
(A) Packaging designed to change color solely to attract consumers for marketing and brand promotion
(B) Packaging composed entirely of edible, starch-based traditional ingredients for biodegradation
(C) Packaging requiring continuous mechanical refrigeration to preserve structural and functional integrity
(D) Packaging incorporating scavengers or emitters in the film to interact with the internal environment

2009
133. What is the primary gas used in Modified Atmosphere Packaging (MAP) for traditional dairy sweets to inhibit aerobic fungal growth?
(A) Pure Oxygen
(B) Carbon monoxide
(C) Carbon dioxide
(D) Hydrogen

2004
134. What is the primary packaging material utilized for packing liquid or semi-solid traditional dairy products, such as Rabri, in portion packs?
(A) Unlined paperboard cartons with wax coatings
(B) Thermoformed plastic cups with sealed foil lids
(C) Jute fiber bags lined with thin plastic sheets
(D) Porous clay pots coated with paraffin wax seals

2012
135. Which packaging system provides the most substantial shelf-life extension for Khoa-based sweets without requiring continuous refrigeration?
(A) Simple polyethylene bagging
(B) Wrapping in butter paper
(C) Packing in rigid cardboard boxes
(D) Retort pouch packaging

2003
136. Which of the following is an INCORRECT pair regarding advanced packaging and its target function?
(A) Nitrogen gas flushing – Promotes the rapid fermentation of Dahi
(B) Oxygen scavengers – Prevent lipid oxidation in fat-rich sweets
(C) Moisture absorbers – Maintain surface

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crispness in specific dry sweets
(D) Antimicrobial films – Inhibit surface mold growth on Paneer

2006

137. If a manufacturer switches from air packaging to a 100% CO_2 Modified Atmosphere Packaging (MAP) system for Paneer, what physicochemical challenge might they face?
(A) The Paneer will instantly turn yellow due to rapid oxidation of carotenoids.
(B) The system will cause the Paneer to spontaneously ferment into Dahi within hours.
(C) The Paneer may absorb CO_2, causing a slightly acidic surface flavor and package collapse.
(D) The gas will completely extract all milk fat from the protein matrix under pressure.

2025

138. Under which category does the packaging of Rasgulla in hermetically sealed tin cans fall?
(A) Rigid, thermally processed packaging
(B) Flexible, active scavenger packaging
(C) Edible, biodegradable film packaging
(D) High-barrier vacuum skin packaging

2013

139. Which packaging attribute is the least relevant when designing a Modified Atmosphere Packaging (MAP) system for a fresh, high-moisture product like Chhana?
(A) Oxygen transmission rate (OTR) of the barrier film material
(B) Water vapor transmission rate (WVTR) of the packaging film
(C) The specific gas mixture ratio injected inside the package headspace
(D) The precise optical transparency and gloss of the outer product label

2025

140. Which of the following statements is correct regarding the vacuum packaging of traditional sweets?
(A) It is highly recommended for very soft, spongy products to maintain shape.
(B) It can deform soft, aerated products due to high physical vacuum pressure.
(C) It inherently sterilizes the product, completely removing pasteurization needs.
(D) It requires continuous, active oxygen injection to stabilize product colors.

2021

141. What is the primary technological advantage of formulating instant dry dessert mixes, such as instant Gulab Jamun mix?
(A) They require specialized, complex industrial machinery for the consumer to hydrate and prepare.
(B) They possess an extremely short shelf life, which encourages rapid consumer product turnover.
(C) They offer convenience, product standardization, and extended shelf life at room temperature.
(D) They contain significantly higher moisture and free water levels than standard traditional sweets.

2014

142. A typical commercial instant Gulab Jamun mix relies on which fundamental base ingredient to mimic the functional properties of traditional Khoa?
(A) Pasteurized fresh fluid whole milk
(B) Purified soy protein isolate powder
(C) Sifted refined white wheat flour only
(D) Skim milk powder and vegetable fat

2008

143. Which of the following statements is INCORRECT regarding the production processes of convenience traditional milk products?
(A) Convenience mixes never require any chemical leavening agents.
(B) Reconstitution parameters are critical to achieving the correct dough consistency.
(C) Emulsifiers are often added to dry mixes to improve fat dispersion during hydration.
(D) Agglomeration techniques can be used to improve the instant solubility of dessert powders.

2013

144. If an instant Rasgulla mix fails to form a cohesive dough upon adding water, which formulation error is most likely responsible?
(A) Excessive addition of chemical leavening agents causing gas release
(B) Insufficient functional milk protein or inappropriate binder ratios
(C) The exclusive use of ultra-fine powdered sugar in the dry formulation
(D) Over-roasting of the flour component during the preliminary dry mixing

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2011

145. Which of the following is a correct pair regarding instant mix ingredients and their functional role?
(A) Sodium bicarbonate – Acts as a chemical preservative agent
(B) Skim Milk Powder – Provides the primary protein gel matrix
(C) Citric acid – Acts as a foaming and stabilizing agent
(D) Maida (refined wheat flour) – Increases the total lipid content

2006

146. What is the primary effect of improper moisture control (such as high humidity exposure) in dry dessert mixes during storage?
(A) Causes caking, lumping, and non-enzymatic browning, making the mix unusable
(B) Causes rapid lipid oxidation, which paradoxically leads to a fresher aroma
(C) Causes the spontaneous structural formation of cooked sweets inside packs
(D) Causes the direct catalytic degradation of milk lactose into pure glucose

2015

147. Which of the following is NOT a critical reconstitution parameter specified on the packaging of instant dairy dessert mixes?
(A) The exact volume of water or milk to be added
(B) The temperature of the reconstituting liquid
(C) The absolute necessity of using distilled water only
(D) The specific resting time required for the dough to hydrate

2016

148. How do the textural outcomes of Gulab Jamun made from fresh Khoa and an instant dry mix containing high levels of cereal binders compare?
(A) Instant mix products are highly liquid and completely fail to retain any stable spherical shape during cooking.
(B) Fresh Khoa products consistently display a tough, rubbery, and highly elastic texture profile after processing.
(C) There is absolutely zero sensory or physical difference identifiable by advanced instruments or human panels.
(D) Instant mix products typically exhibit a denser, more doughy, and slightly less creamy mouthfeel than Khoa.

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2018

149. How is "convenience food" defined in the context of traditional dairy products?
(A) A raw food item requiring more than 24 hours of active preparation by the consumer
(B) A raw agricultural commodity that has undergone no industrial or thermal processing
(C) A product processed to a degree requiring minimal further preparation before eating
(D) A specialized agricultural byproduct intended exclusively for livestock feed use

2010

150. What is the primary role of adding hydrocolloids (such as guar gum or alginate) to instant dairy dessert mixes?
(A) To induce severe Maillard browning reactions upon hydration
(B) To improve moisture retention, dough binding, and final texture
(C) To act as a primary carbohydrate-based sweetening agent in mix
(D) To act as a highly effective, active preservation compound

2024

151. The thermal processing parameter known as the "F_0 value" in canning operations is a measure of:
(A) The total fat and solid-not-fat percentage of the finished canned dairy product
(B) The final thermodynamic pH of the sterilized food matrix measured post-retorting
(C) The negative vacuum pressure developed inside the hermetically sealed container
(D) The lethality of heat treatment expressed as equivalent minutes at 121.1°C

2010

152. Which traditional Indian dairy sweet is most commonly commercialized in a retort-processed, canned format due to its specific matrix stability?
(A) Rasgulla
(B) Sandesh
(C) Kalakand
(D) Fresh Chhana

2011

153. Which of the following is an INCORRECT pair linking a thermal processing step to its technological function in canned sweets?
(A) Exhausting – Removal of air from the can before sealing
(B) Seaming – Creating a hermetic double seam to prevent recontamination
(C) Incubation – Cooling the cans rapidly in a

blast freezer
(D) Retorting – Commercial sterilization of the sealed product

2024
154. If a batch of canned Rasgulla exhibits "flat sour" spoilage after 6 months of storage, what can be inferred about the thermal processing?
(A) The process was insufficient to destroy thermophilic spore-forming bacteria.
(B) The product was subjected to excessive thermal heat, causing caramelization.
(C) The can seams were breached, allowing external aerobic molds to easily grow.
(D) The initial sugar syrup concentration was too high to prevent osmophilic yeast.

2002
155. Retort pouch processing of dairy sweets is primarily classified as an application of:
(A) Low-temperature long-time (LTLT) pasteurization
(B) High-temperature short-time (HTST) pasteurization
(C) Non-thermal preservation
(D) Commercial sterilization technology

2018
156. Which of the following parameters is least relevant to determining the required thermal lethality (F_0 value) for a canned traditional dairy product?
(A) The initial microbial load (bioburden)
(B) The exact font size of the nutritional label
(C) The pH of the product
(D) The heat penetration characteristics of the specific food matrix

2018
157. Which of the following statements is correct regarding the long-life canning of Kheer (rice pudding)?
(A) Kheer cannot be canned because rice kernels instantly dissolve and disintegrate under retort pressure.
(B) The sterilization F_0 value for Kheer is set to zero to preserve the delicate cooked flavor compounds.
(C) Retorting alters the starch-casein matrix rheology, requiring careful stabilizer formulation.
(D) Kheer is a highly acidic product, thereby only requiring mild pasteurization temperatures for canning.

2015
158. What is the primary advantage of utilizing flexible retort pouches over traditional metal cans for long-life dairy sweets?
(A) They are inherently immune to all forms of physical puncture or tearing during transportation.
(B) They completely absorb all UV light, preventing any lipid oxidation or chemical reactions in food.
(C) They naturally generate their own internal vacuum environment without requiring any mechanical processing.
(D) They possess a thinner profile, allowing faster heat penetration and reducing thermal damage.

2007
159. The commercial sterilization of canned Gulab Jamun typically targets the destruction of spores from which pathogenic microorganism?
(A) Clostridium botulinum
(B) Salmonella typhi
(C) Listeria monocytogenes
(D) Escherichia coli

2023
160. Which of the following statements is INCORRECT regarding the thermal processing parameters of traditional sweets?
(A) High sugar concentrations in syrups can exert a protective effect on bacterial spores, increasing required heating times.
(B) Agitating retorts are never used for dairy products as they immediately cause fat churning.
(C) Rapid cooling post-retorting is essential to prevent structural collapse and overcooking of the sweets.
(D) The internal temperature at the cold spot of the can determines the adequacy of the process.

2021
161. Which food preservation approach is represented by formulating a sweet using partial desiccation (reducing water activity), the addition of potassium sorbate, and flushing with nitrogen gas?
(A) Fermentation technology
(B) Hurdle technology
(C) Extrusion technology
(D) Membrane technology

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2008

162. Which of the following is a correct pair of a hurdle technology parameter and its direct mechanism of action?

(A) Lowered pH – Disrupts cellular homeostasis in spoilage microbes

(B) Low water activity (a_w) – Denatures microbial DNA via radiation

(C) High pressure – Induces rapid, spontaneous lactose crystallization

(D) Addition of natamycin – Prevents lipid oxidation of milk fats

2010

163. What is the effect of manipulating the redox potential (Eh) via vacuum packaging in a traditional dairy product?

(A) Causes a massive increase in available headspace oxygen, promoting rapid fungal mold growth.

(B) Causes an immediate drop in pH, which creates an acid-coagulated, unstable protein matrix.

(C) Causes a highly reducing environment, inhibiting strict aerobes like molds and bacteria.

(D) Causes the spontaneous and hazardous generation of pure hydrogen gas within the container.

2001

164. Which of the following is NOT considered a typical "hurdle" used in the preservation of traditional Indian dairy products?

(A) High processing temperature (F-value)

(B) Reduced water activity through sugar addition

(C) Competitive flora (e.g., lactic acid bacteria in Dahi)

(D) Intentional contamination with spoilage yeast

2021

165. How do the applications of hurdles in Peda and fresh Paneer compare?

(A) Paneer relies on high added sugar and low a_w; Peda relies exclusively on low pH and anaerobic packaging.

(B) Both products rely entirely on competitive fermentation processes driven by beneficial molds and yeasts.

(C) Peda relies heavily on low a_w and high sugar; Paneer relies on refrigeration and low initial microbial load.

(D) Neither product utilizes any form of hurdle technology, relying strictly on synthetic chemical preservatives.

2011

166. How is "water activity (a_w)" defined in the context of hurdle technology for dairy sweets?

(A) The total percentage of moisture and free water bound chemically within the finished dairy product matrix.

(B) The ratio of the water vapor pressure in food to that of pure water at the same temperature.

(C) The speed at which moisture evaporates from the food surface into the surrounding atmosphere during storage.

(D) The total volume of added water or reconstituted liquid milk introduced during the initial processing stages.

2001

167. What is the primary hurdle that grants Ghee its exceptionally long shelf life at room temperature?

(A) Extremely low pH

(B) High concentration of added preservatives

(C) Intense vacuum packaging

(D) Extremely low water activity (a_w near 0)

2012

168. The intentional lowering of pH in Shrikhand to around 4.2–4.4 serves as a critical hurdle primarily effective against:

(A) Pathogenic bacteria and putrefactive spoilage organisms

(B) Acidophilic yeasts that tolerate high acidity levels

(C) Xerophilic molds that thrive under low water activity

(D) Extreme thermophiles that survive boiling pasteurization

2014

169. What is the most appropriate strategy for extending the shelf life of a high-moisture sweet like Rasgulla using hurdle technology without canned sterilization?

(A) Drastically increasing the water activity to 0.99 to promote hydration.

(B) Exposing the product to open air to allow natural surface desiccation.

(C) Adding a permitted antimycotic and lowering the syrup pH slightly.

(D) Removing all sugar content to eliminate osmotic pressure effects.

NODIA

2023

170. Which of the following is an INCORRECT pair regarding chemical preservatives used as hurdles in dairy sweets?

(A) Natamycin – Primarily inhibits Gram-negative bacteria like E. coli

(B) Sorbic acid – Inhibits molds and yeasts

(C) Nisin – Effective against Gram-positive bacteria and spores

(D) Benzoic acid – Antimicrobial agent often limited by strict regulatory levels

2016

171. If a dairy plant utilizes Ultrafiltration (UF) to concentrate milk proteins prior to Chhana making, what can be inferred about the subsequent coagulation step?

(A) Coagulation will require less acid, yielding a highly fine, non-cohesive precipitate.

(B) Coagulation will occur spontaneously without requiring any thermal heating or acid addition.

(C) The process will fail completely because ultrafiltration removes all micellar casein from milk.

(D) The resulting coagulum will have higher mineral and whey protein content in the matrix.

2025

172. Under membrane processing technology, Reverse Osmosis (RO) is primarily classified as:

(A) A fractionation process separating proteins from lactose molecules

(B) A concentration process that removes only water from the feed

(C) A sterilization process destroying all viable microbial life

(D) A texturization process altering the natural fat globule structure

2001

173. Which operational parameter is the least relevant when evaluating the rejection coefficient of a Reverse Osmosis membrane for milk concentration?

(A) Transmembrane pressure across the membrane boundary

(B) Feed temperature of the incoming liquid milk

(C) The external color of the membrane housing unit

(D) Feed flow rate and turbulence inside the module

2023

174. Which of the following statements is correct regarding the application of Ultrafiltration (UF) for Shrikhand manufacture?

(A) UF cannot be used because it removes all of the milk fat during filtration.

(B) UF strictly requires boiling milk at 150°C during the filtration run.

(C) UF decreases overall yield by losing critical whey proteins in the permeate.

(D) UF concentrates milk prior to fermentation, eliminating the traditional whey drainage step.

2007

175. What is a primary technological advantage of using Diafiltration alongside Ultrafiltration in the commercial manufacture of traditional dairy products?

(A) It washes out lactose and soluble minerals while retaining proteins, lowering carbohydrate content.

(B) It intentionally increases the lactose content of the retentate to enhance thermal Maillard browning.

(C) It completely eliminates the physical need for high-pressure feed pumping systems in the plant.

(D) It converts incoming liquid milk directly into a highly soluble dry powder in a single operation.

2002

176. The permeate obtained during the Ultrafiltration of milk primarily contains:

(A) Casein micelles, insoluble minerals, and large milk fat globules

(B) Water, lactose, soluble salts, and non-protein nitrogen

(C) Denatured whey proteins, globulins, and complex carbohydrates

(D) Pure water molecules completely free of any dissolved solutes

2005

177. Which of the following statements is INCORRECT concerning the membrane processing of traditional dairy products?

(A) UF Paneer exhibits a smoother, less granular texture than conventional Paneer.

(B) Membrane fouling is a minor issue that rarely affects commercial continuous runs.

(C) RO can pre-concentrate milk, reducing thermal energy required for Khoa making.

(D) Retention of whey proteins in UF Chhana

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increases the total nutritional yield.

2022

178. What is the expected outcome of concentrating milk to 2.5X using Reverse Osmosis prior to Rabri production?

(A) The structure of malai flakes remains identical to conventional methods, but with reduced boiling time.

(B) The Rabri will require significantly more boiling time and higher energy inputs to achieve consistency.

(C) The concentrated milk will immediately curdle and coagulate inside the RO membrane channel.

(D) The resulting sweet Rabri product will possess absolutely zero lactose or soluble sugar content.

2022

179. Which of the following is a correct pair mapping a membrane process to its typical operating pressure range in dairy applications?

(A) Ultrafiltration (UF) – 100 to 150 bar (Extreme pressure)

(B) Microfiltration (MF) – 30 to 60 bar (High pressure)

(C) Reverse Osmosis (RO) – 30 to 60 bar (High pressure)

(D) Nanofiltration (NF) – 1 to 2 bar (Low pressure)

2019

180. What is the effect of incorporating Ultrafiltration (UF) retained whey proteins into the matrix of Paneer?

(A) Causes the finished Paneer to become excessively crumbly, dry, and difficult to slice cleanly.

(B) Causes severe lipid oxidation and extremely rapid development of rancid off-flavors in storage.

(C) Causes the complete and immediate failure of the acid-induced hot milk coagulation process.

(D) Causes higher water-binding, resulting in a softer texture and increased product yield.

2023

181. Which of the following is NOT a primary technological function of food additives like hydrocolloids in traditional dairy products?

(A) Preventing syneresis and whey separation during storage

(B) Modifying the rheological and textural properties of foods

(C) Enhancing nutritional profiles by providing essential vitamins

(D) Improving the thermodynamic stability of oil-in-water emulsions

2008

182. How do the texturizing effects of Carrageenan and Carboxymethyl Cellulose (CMC) compare when applied as stabilizers in commercial dairy desserts?

(A) Both substances are functional proteins that induce rapid acid coagulation.

(B) Carrageenan gels by interacting with casein, while CMC thickens by binding water.

(C) CMC functions purely as a sweetening agent, while Carrageenan is a strong acidulant.

(D) Carrageenan acts to decrease viscosity, while CMC acts to increase the fat content.

2002

183. How is "hydrocolloid" defined in the context of improving traditional dairy products?

(A) A synthetic organic dye utilized primarily to impart highly vibrant, appealing colors.

(B) A highly concentrated and purified form of milk fat used to boost rich dairy flavor.

(C) An intensely sweet chemical compound designed to substitute for standard sucrose.

(D) A hydrophilic polymer dispersing in water to increase viscosity or form stable gels.

NODIA

2015

184. Which of the following additives is commonly utilized to prevent the physicochemical defect of sandiness (lactose crystallization) in concentrated dairy products?

(A) Microcrystalline cellulose or specialized food gums

(B) Sodium chloride salts added during hot concentration

(C) Ascorbic acid used to modulate final pH levels

(D) Annatto extract dye used to modify product color

2023

185. The addition of Sodium Alginate to a dairy product matrix typically requires the presence of which specific ion to form a stable gel structure?

(A) Sodium

(B) Potassium

(C) Calcium

(D) Iron

2009

186. Which food additive is most appropriately selected to improve the structural integrity and prevent crumbling in industrially manufactured Peda?
(A) Maltodextrin or specialized starches
(B) Potassium sorbate mold inhibitors
(C) BHA (Butylated Hydroxyanisole)
(D) Lactic acid chemical acidulants

2024

187. Which of the following is an INCORRECT pair regarding food additives and their targeted function in traditional dairy products?
(A) Pectin – Textural improvement and gelation in set desserts
(B) Guar gum – Prevents whey separation in Shrikhand
(C) Sodium citrate – Acts as an emulsifying salt to stabilize protein networks
(D) Lecithin – Acts as an intensely potent artificial sweetener

2006

188. If a manufacturer of Gulab Jamun dry mix adds a higher proportion of baking powder (sodium bicarbonate and an acid salt), what textural outcome can be directly inferred?
(A) The fried dough balls will be extremely dense, hard, and rubbery in texture.
(B) The product will have a highly porous, spongy, and expanded core upon heating.
(C) The finished sweet product will completely resist any sugar syrup absorption.
(D) The dry mix will immediately undergo extensive Maillard browning in storage.

2007

189. Stabilizers like locust bean gum and xanthan gum are primarily classified chemically as:
(A) Simple monosaccharide sugars
(B) Long polypeptide chains
(C) Complex polysaccharides
(D) Simple lipid triglycerides

2014

190. Which attribute is the least relevant when selecting a specific hydrocolloid for commercial Dahi production?
(A) Its chemical interaction with casein micelles at low pH levels
(B) Its specific water-binding capacity within the fermented gel
(C) Its thermal processing tolerance during milk pasteurization
(D) Its inherent color in a completely dry, unhydrated state

2011

191. Which of the following statements is correct regarding the formulation of low-fat traditional dairy products?
(A) Low-fat Paneer suffers from a hard, rubbery, and dry texture without interventions.
(B) Removing fat generally improves the sensory profile, making the final product richer in taste.
(C) Fat extraction increases the shelf life of fresh Chhana by entirely halting bacterial growth.
(D) Dietetic milk sweets mandate the addition of extremely high levels of standard cane sucrose.

2010

192. What is a primary technological advantage of incorporating microparticulated whey proteins as fat-replacers in traditional dairy products?
(A) They act as powerful artificial sweeteners in low-calorie dessert formulations.
(B) They mimic the creamy mouthfeel of milk fat without adding the high lipid calories.
(C) They are highly resistant to human digestion, passing straight through the gut tract.
(D) They completely prevent any lactose crystallization defect in concentrated milk sweets.

2011

193. Which class of fat replacers is derived directly from carbohydrates and commonly used to improve the texture of low-fat dairy desserts?
(A) High-intensity sweeteners like Sucralose and Aspartame
(B) Modified starches, maltodextrins, and polydextrose
(C) Synthetic lipid-based fat substitutes like Olestra
(D) Highly soluble proteinates such as Sodium caseinates

2004

194. Which of the following statements is INCORRECT regarding the application of fat-replacers in formulating dietetic Paneer?
(A) Protein fat replacers withstand boiling paneer coagulation without denaturing.
(B) Carbohydrate-based replacers function by binding water and increasing moisture.
(C) Using fat replacers helps mitigate the rubbery chewiness of skim milk Paneer.
(D) Fat replacers cannot fully replicate the

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flavor-carrying traits of milk fat.

2014

195. What dual purpose does inulin serve in a dietetic formulation of low-fat Shrikhand?
(A) It acts as a highly powerful chemical preservative and a natural yellow colorant.
(B) It completely digests milk lactose and directly ferments the curd into Shrikhand.
(C) It acts as both a bulking/fat-mimetic agent and a prebiotic dietary fiber.
(D) It functions as a chemical leavening agent and a strong organic acidulant.

2009

196. Which of the following represents a correct pair classifying the type of fat replacer?
(A) Microparticulated whey – Carbohydrate-based
(B) Polydextrose – Functional protein-based
(C) Maltodextrin – Structured lipid-based
(D) Olestra – Synthetic lipid-based polyester

2021

197. What is the effect of significantly reducing the fat content in Khoa without adding any mimetics or adjusting moisture?
(A) Causes a profound, sudden increase in the perceived sweetness of the Khoa matrix.
(B) Causes the complete, absolute prevention of natural thermal Maillard browning.
(C) Causes a tough, dry, granular texture with compromised binding properties.
(D) Causes the finished product to turn a bright, intense white color indefinitely.

2017

198. Which of the following is NOT a technological challenge encountered when formulating low-fat Indian dairy sweets?
(A) Loss of the characteristic rich, creamy flavor and lubricity of the sweet
(B) Development of an excessively soft, flowing structure due to high fat levels
(C) Increased hardness, toughness, and rubberiness of the coagulated protein matrix
(D) Altered heat transfer rates and thermodynamic behaviors during thermal processing

2007

199. How do carbohydrate-based and protein-based fat replacers compare in high-heat dairy applications like Khoa desiccation?
(A) Protein-based replacers remain highly stable, while carbohydrate-based ones instantly denature.
(B) Both replacers perform identically under all high-heat desiccation and evaporation conditions.
(C) Neither type of fat replacer can be successfully utilized in dairy processing operations.
(D) Carbohydrate-based replacers are heat-stable, whereas protein-based ones may denature.

NODIA

2021

200. How are "dietetic" traditional dairy products defined?
(A) Products formulated with modified nutrition profiles to meet specific dietary needs.
(B) Products designed strictly to induce rapid weight gain in undernourished consumer groups.
(C) Products manufactured entirely from non-dairy ingredients without using any bovine milk.
(D) Products developed and meant exclusively for high-performance domestic animal consumption.

2023

201. Which intense artificial sweetener is a chlorinated derivative of sucrose?
(A) Aspartame
(B) Saccharin
(C) Sucralose
(D) Stevioside

2015

202. Which bulking agent is frequently utilized alongside intense artificial sweeteners to replicate the physical volume and mouthfeel of sucrose in diabetic-friendly Barfi?
(A) Sorbitol or Polydextrose
(B) Sodium chloride
(C) High fructose corn syrup
(D) Monosodium glutamate

2014

203. Which of the following intense artificial sweeteners is generally avoided in products that require prolonged, intense thermal processing, such as boiling sugar syrups for Rasgulla, due to its thermal instability?
(A) Sucralose
(B) Acesulfame-K
(C) Saccharin
(D) Aspartame

2013

204. Which of the following is INCORRECT regarding sugar replacers and their characteristics?
(A) Erythritol – Sugar alcohol, provides zero calories, high digestive tolerance
(B) Xylitol – Intense artificial sweetener structurally similar to aspartame
(C) Stevia – Natural high-intensity sweetener extracted from leaves
(D) Maltitol – Sugar alcohol with a sweetness profile very close to sucrose

2010

205. If a manufacturer replaces 100% of sucrose in Kalakand with an equivalent sweetness dose of liquid Sucralose, what physical defect can be inferred?
(A) The product will spontaneously explode due to rapid internal gas formation.
(B) The product will instantly undergo extremely intense, dark Maillard browning.
(C) The product will suffer a drastic loss of mass and body due to lack of sugar bulk.
(D) The product will become completely transparent and lose its typical opaque color.

2014

206. Sugar alcohols (polyols) used in low-calorie traditional sweets are chemically classified as:
(A) High-intensity non-nutritive sweeteners
(B) Polypeptide chains
(C) Synthetic triglycerides
(D) Hydrogenated carbohydrates

2004

207. Which characteristic of sucrose is the least relevant when attempting to replicate its function using bulking agents in diabetic-friendly sweets?
(A) Its specific optical rotation value in a polarimeter
(B) Its contribution to the total solids and product yield
(C) Its role in depressing the water activity (aw) for preservation
(D) Its ability to undergo crystallization during product setting

2010

208. Which of the following statements is correct regarding the physiological effects of excessive consumption of sugar alcohols, such as sorbitol, in diabetic dairy sweets?
(A) They cause an immediate, life-threatening spike in blood glucose and insulin levels.
(B) They cause gastrointestinal distress and laxative effects due to poor absorption.
(C) They completely and permanently destroy beneficial probiotic intestinal microflora.
(D) They induce severe, acute clinical dehydration and electrolyte imbalance in hours.

NODIA

2016

209. What is a key advantage of utilizing Acesulfame Potassium (Ace-K) in blended sweetener profiles for traditional dairy sweets?
(A) It provides exactly the same caloric and energy value per gram as standard cane sucrose.
(B) It exhibits excellent heat stability and has a synergistic effect in sweetener blends.
(C) It acts as a primary bulking and texturizing agent, fully replacing lost sugar mass.
(D) It actively and rapidly promotes extensive Maillard browning reactions during cooking.

2019

210. The natural sweetener extracted from Siraitia grosvenorii is commonly known as:
(A) Monk fruit extract
(B) Agave nectar
(C) Yacon syrup
(D) Thaumatin

2005

211. Which of the following statements is INCORRECT regarding the operational parameters of Scraped Surface Heat Exchangers (SSHE) in milk desiccation?
(A) The rotor speed critically influences the residence time and heat transfer coefficient.
(B) The scraper blades prevent burn-on by continuously sweeping the heated cylindrical surface.
(C) SSHE operations strictly require batch processing and cannot operate continuously.
(D) The clearance between the blade and the heat transfer surface affects the product's final texture.

2001

212. What adjustment is required when scaling up Khoa production using an inclined Scraped Surface Heat Exchanger (SSHE) if the product lacks the desired cooked flavor and browning?
(A) Drastically increase rotor speed while simultaneously decreasing the jacket steam pressure.
(B) Dilute the incoming concentrated milk feed with fifty percent water prior to processing.
(C) Remove all scraper blades from the rotor shaft assembly to allow natural burn-on

layers.

(D) Increase the residence time or elevate jacket steam pressure to enhance thermal exposure.

2018

213. Which of the following represents a correct pair relating a component of a Scraped Surface Heat Exchanger (SSHE) to its engineering function?

(A) Heating jacket – Rapidly freezes the milk mixture

(B) Scraper blades – Induces homogenization of fat globules under extreme pressure

(C) Rotor shaft – Drives the blades to ensure continuous surface renewal and mixing

(D) Feed pump – Extracts the final desiccated mass

2015

214. What is the effect of insufficient scraper blade pressure against the heat exchange surface in a Scraped Surface Heat Exchanger (SSHE) during milk concentration?

(A) Causes a sudden, rapid drop in product temperatures inside the heat exchange cylinder.

(B) Causes a burn-on layer, reducing heat transfer efficiency and imparting scorched flavor.

(C) Causes excessive, uncontrolled incorporation of air bubbles into the thick product matrix.

(D) Causes complete and irreversible thermal destruction of all essential vitamins in milk.

2009

215. Which of the following is NOT a typical engineering design advantage of a Conical Vat used for milk desiccation compared to a flat-bottomed open pan?

(A) Enhanced convective mixing dynamics

(B) Easier mechanical removal of the highly viscous final product from the bottom apex

(C) Improved steam jacketing efficiency due to specific geometric surface-to-volume ratios

(D) Ability to process continuously without any human or mechanical intervention

2004

216. How do the continuous Scraped Surface Heat Exchanger (SSHE) system and the Conical Vat system compare for industrial Khoa making?

(A) SSHE handles transitions continuously in cylinders; Conical Vat operates as a batch concentrator.

(B) Conical Vats utilize direct flame heating, while SSHE systems rely on electrical resistance coils.

(C) SSHE systems require manual intervention, whereas Conical Vat setups are automated and robotic.

(D) Conical Vats yield a completely dry powder, while SSHE designs yield a highly fluid liquid sweet.

2012

217. In the context of Scraped Surface Heat Exchanger (SSHE) scale-up, how is "residence time" defined?

(A) The time required for a completely new machine to be fully installed and commissioned in a plant.

(B) The time required to cool down the hot finished product post-processing prior to final packaging.

(C) The average duration a specific fluid element spends inside the active heat exchanger cylinder.

(D) The time required for lactose sugar crystals to fully nucleate and grow in the cooled product.

2017

218. What is the primary material of construction required for the heat transfer surface and scraper blades in modern Scraped Surface Heat Exchangers (SSHE) to meet food safety and durability standards?

(A) Stainless steel cylinder with food-grade polymer or specialized alloy blades

(B) Pure industrial copper cylinder fitted with untreated, high-density iron blades

(C) Heavy-duty aluminum cylinder fitted with traditional heat-treated wooden blades

(D) Glass-lined thermal cylinder fitted with high-friction industrial ceramic blades

2006

219. Scaling up continuous milk desiccation processes primarily relies on maintaining a constant:

(A) The specific aesthetic color of the processing room walls and floors

(B) The commercial brand name of the raw milk utilized in the process

(C) The atmospheric barometric pressure measured outside the dairy plant

(D) The overall heat transfer coefficient and surface-to-volume ratio

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2010

220. Which operational parameter must be strictly controlled in a Conical Vat to prevent mechanical shear damage to the developing Khoa matrix?
(A) The pressure of the steam inside the heating jacket
(B) The rotational speed of the internal scraper assembly
(C) The lactic acidity and pH of the incoming liquid milk
(D) The relative humidity level of the exhaust vapor vent

2002

221. Which of the following is an INCORRECT pair regarding mechanized traditional dairy equipment and its primary function?
(A) Continuous Chhana maker – Coagulates milk and separates whey in a single flowing process
(B) Paneer hoop pressing system – Applies controlled pneumatic or hydraulic pressure to form blocks
(C) Mechanized sweet-forming equipment – Roasts raw milk directly into dry powder
(D) SSHE – Continuously concentrates milk to high solids

2012

222. If a continuous Chhana making machine utilizes a tubular coagulation section with a highly turbulent flow regime, what can be inferred about the resulting coagulum?
(A) It will form massive, highly cohesive blocks of curd requiring manual cutting.
(B) It will completely dissolve and return to a liquid state under high turbulence.
(C) It will undergo severe lipid oxidation and off-flavor generation instantly.
(D) It will consist of finely dispersed curd particles due to high-shear mixing.

2014

223. Mechanized sweet-forming equipment, such as encrusting machines or automatic ball formers for Gulab Jamun, is primarily classified as:
(A) Rheological manipulation and portioning technology
(B) Continuous thermal desiccation and roasting systems
(C) Industrial fermentation bioreactor and incubation units
(D) Centrifugal separation and product clarification systems

2010

224. Which parameter is the least relevant when designing a pneumatic pressing system for industrial Paneer manufacturing?
(A) The specific pressure applied per square centimeter of the curd surface
(B) The exact aerodynamic drag coefficient of the external machine casing
(C) The duration of the pressure application
(D) The drainage efficiency of the perforated molds

2017

225. Which of the following statements is correct regarding the engineering design of continuous Chhana making machines?
(A) They operate effectively only at sub-zero temperatures using brine circulation systems.
(B) They incorporate a specialized draining conveyor or rotary screen to separate hot whey.
(C) They utilize high-pressure homogenizers to form the final Chhana structure during cooling.
(D) They require the incoming milk to be perfectly stationary during the acid addition stage.

NODIA

2013

226. What is the primary advantage of utilizing mechanized encrusting and forming equipment for traditional sweets like Peda and Gulab Jamun?
(A) High-speed portion control, weight standardization, and hygienic handling
(B) Complete elimination of all added sugars and carbohydrate-derived bulking agents
(C) Guarantee of zero absolute microbial load and commercial sterility in the sweet
(D) Spontaneous creation and synthesis of highly aromatic artificial flavor compounds

2016

227. In modern large-scale Paneer production, what type of pressing system has largely replaced manual dead-weight pressing?
(A) Continuous centrifugal clarifiers
(B) Fluidized bed drying chambers
(C) Pneumatic or hydraulic presses
(D) Industrial vacuum evaporators

2016

228. Which of the following statements is INCORRECT regarding the functionality of continuous Chhana makers?

(A) They significantly reduce the labor required compared to batch methods.
(B) They allow for the precise, automated dosing of the acidulant.
(C) They recover whey continuously, allowing for efficient secondary processing.
(D) They are completely incapable of producing Chhana suitable for Rasgulla.

2014

229. Which variable should be adjusted first if a continuous Chhana maker is producing a rubbery, excessively tough product?
(A) Increase the operating speed of the main whey drainage conveyor belt.
(B) Turn off the machinery and switch processing entirely to batch methods.
(C) Lower the milk injection temperature or decrease the acidulant strength.
(D) Increase the atmospheric pressure of the final vacuum packaging chamber.

2023

230. Which of the following represents a correct pair of a mechanized equipment stage and its critical design feature?
(A) Coagulation tube – Equipped with high-efficiency cooling jackets to freeze the milk matrix
(B) Whey conveyor – Comprises a moving mesh belt allowing rapid liquid gravity separation
(C) Paneer molds – Manufactured from solid, unperforated steel designed to retain moisture
(D) Sweet ball former – Operates strictly under high mechanical vacuum to remove air pockets

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ANSWERS

1. (A) Higher total solids and larger fat globule size
Buffalo milk possesses a higher concentration of total solids, particularly fat and casein, along with larger fat globules compared to cow milk. These unique physico-chemical attributes facilitate a higher yield and superior textural characteristics during thermal concentration. Consequently, buffalo milk is highly preferred for preparing premium quality, cohesive, and smooth heat-desiccated dairy products.

2. (B) Both A and R are true but R is not the correct explanation of A.
Manufacturing paneer from buffalo milk involves coagulation at a slightly lower temperature to prevent the formation of an excessively hard, rubbery texture. Separately, buffalo milk is characterized by a higher buffering capacity and a greater concentration of micellar casein compared to cow milk. While both facts are scientifically accurate, the chemical buffering capacity does not directly dictate the chosen temperature adjustment.

3. (A) Cow milk has a higher proportion of saturated fatty acids.
Buffalo milk fat actually contains a higher proportion of saturated fatty acids and lower levels of unsaturated fatty acids compared to cow milk fat, which contributes to its firmer texture. Conversely, buffalo milk features a higher calcium content, faster enzymatic clotting times, and a higher pH, making the statement regarding cow milk having more saturated fatty acids incorrect.

4. (D) I and III
Buffalo milk is distinct because carotene is completely absent, as the animal efficiently converts it into vitamin A, resulting in white milk fat. Additionally, the heat stability of buffalo milk is inherently lower than that of cow milk due to higher calcium concentration. However, buffalo milk has a higher viscosity, which makes the second statement incorrect.

NODIA

5. (B) A distinctly greenish-white tint in resultant Chhana
Buffalo milk possesses a natural greenish-white color due to the presence of the pigment biliverdin, alongside the complete absence of carotenoid pigments in its fat phase. Consequently, products manufactured from buffalo milk, such as Chhana, exhibit a characteristic greenish-white tint, whereas cow milk products tend to have a yellowish appearance due to active carotenoids.

6. (B) P-3, Q-1, R-2, S-4
High fat content in milk increases the yield of Rabri by forming substantial fat-rich layers. The absence of beta-carotene ensures a whiter color in Khoa. Elevated calcium and phosphorus levels produce a firmer Paneer texture through strong ionic bridges. Finally, larger casein micelles restrict starter culture activity, resulting in slower acid development during Dahi fermentation.

7. (D) Casein micelles – Drive the textural firmness in heat-desiccated Khoa
Casein micelles represent the primary structural proteins in milk, and their concentration and aggregation behavior directly dictate the final textural firmness of heat-desiccated products like Khoa. While lactose acts as a soluble sweetener and whey proteins remain soluble unless denatured, the integrated casein micelle network forms the fundamental structural backbone of traditional concentrated dairy products.

8. (A) Buffalo milk exhibits greater susceptibility to heat-induced browning.
Buffalo milk contains higher levels of total solids, proteins, and lactose compared to cow milk, which accelerates non-enzymatic browning under intense thermal conditions. This higher concentration of reactive amino groups and reducing sugars promotes the Maillard reaction, making buffalo milk more susceptible to rapid browning during open-pan heat desiccation processes.

9. (B) Optimization of textural firmness and moisture retention in coagulated products
Blending cow and buffalo milk allows manufacturers to balance the high fat and protein

levels of buffalo milk with the higher moisture retention of cow milk. This technological optimization produces coagulated products, like Paneer or Chhana, with ideal softness, elasticity, and water-holding capacity, preventing the final products from becoming excessively hard or crumbly during commercial processing.

10. (B) Calcium
Buffalo milk contains a significantly higher concentration of calcium, particularly in the colloidal state, compared to cow milk. This abundance of calcium ions plays a critical role in stabilizing casein micelles by forming strong ionic linkages. Consequently, this high mineral content directly influences the coagulation behavior, heat stability, and overall structural firmness of derived dairy products.

11. (A) Increasing consumer demand for packaged, ready-to-eat ethnic sweets
The primary driver for scaling up the traditional dairy sector is the rising consumer preference for hygienic, standardized, and packaged ethnic sweets. Rapid urbanization, changing lifestyles, and growing disposable incomes have shifted consumer behavior toward branded, ready-to-eat dairy products, prompting dairy industries to transition from manual, small-scale halwai operations to highly automated, large-scale commercial manufacturing setups.

12. (C) Enhanced standardization and export market penetration
Transitioning traditional dairy manufacturing to organized industrial scaling ensures precise process control, consistent product composition, and strict hygiene standards. This systematic standardization allows commercial brands to meet stringent international food safety regulations. Consequently, it facilitates wider retail distribution, enhances consumer trust, and significantly increases the export market penetration of traditional Indian dairy sweets.

13. (A) I, III and IV
The unorganized sector still dominates Khoa production, while profit margins on ethnic dairy sweets are actually much higher than those on fluid milk. Furthermore, complete mechanization has not occurred, as manual operations remain widespread across rural areas. Therefore, the statements claiming organized monopoly, low profit margins, and complete nationwide mechanization are incorrect.

14. (C) The unorganized sector currently accounts for zero percent of indigenous milk sweets.
The unorganized sector, consisting of local halwais and cottage-scale processors, still commands a massive share of the traditional dairy sweets market in India. Although industrial mechanization is expanding rapidly, the assertion that the unorganized sector accounts for zero percent of indigenous milk sweets is entirely false, as they remain highly dominant players in regional markets.

15. (B) Retrospective desire to lower the nutritional value of milk
Industrialization of traditional dairy products focuses on achieving quality consistency, regulatory compliance, and economies of scale. Processors aim to preserve or enhance the inherent nutritional value of milk while improving product safety and shelf life. Therefore, any intent to deliberately lower the nutritional quality of milk is completely contrary to the objectives of modern dairy processing.

16. (D) High-value added dairy products
Under economic contribution frameworks, traditional dairy products are categorized as high-value added commodities due to the significant processing, concentration, and formulation involved. Converting liquid milk into products like Khoa, Chhana, Shrikhand, or ghee drastically increases the market value per unit volume, offering dairy processors much higher profit margins compared to standard pasteurized liquid milk.

17. (A) Both A and R are true and R is the correct explanation of A.
The commercial production of indigenous dairy products has expanded rapidly due to rising urban demand for consistent volume and safety. Because traditional, decentralized halwais rely on manual practices that struggle to meet modern microbiological and quality standards at high volumes, organized dairy plants have scaled up operations, directly driving the transition toward automated, large-scale commercial manufacturing.

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18. (C) Regulated industrial entities operating under standardized processing and legal safety frameworks
Within the dairy industry, the organized sector is characterized by structured, registered industrial plants, including cooperatives and private corporations. These entities operate under national food safety licenses, utilize standardized mechanical processing methods, and implement strict quality control protocols. This distinguishes them from decentralized, unregulated local middlemen and traditional household processors in the informal dairy market.

19. (A) Traditional milk sweets – Low volume, low margin
Traditional milk sweets are highly valued because they represent high-margin products with growing retail volumes in the dairy market. While liquid milk operates as a high-volume, low-margin utility commodity, ethnic sweets allow for significant value addition and excellent profitability, making the classification of traditional milk sweets as low volume and low margin incorrect.

20. (D) 50-55%
Approximately half of the total milk produced in India, estimated around fifty to fifty-five percent, is channeled into the manufacturing of traditional dairy products. This massive utilization highlights the cultural and economic significance of indigenous sweets, Paneer, and ghee, which serve as crucial vehicles for conserving surplus milk and generating high-value revenue for dairy farmers.

21. (A) IV, II, I, III
Ghee is virtually anhydrous, containing less than one percent moisture, representing the lowest level. Pindi Khoa is concentrated to a semi-solid state containing approximately thirty percent moisture. Chhana retains more water, with moisture levels around fifty-five percent. Rabri, being a sweetened, partially concentrated liquid dessert, maintains the highest moisture content among these traditional dairy products.

22. (C) Malai
Malai is classified as a fat-rich traditional dairy product, prepared by heating milk and allowing a thick layer of fat and coagulated proteins to rise to the surface. Unlike Shrikhand, which is fermented, or Kalakand and Rasgulla, which are protein-coagulated sweets, Malai represents a highly concentrated fat emulsion containing substantial milk lipids.

23. (D) Sandesh
Basundi, Rabri, and Kheer are all manufactured through the progressive thermal desiccation and concentration of liquid milk over open heat. In contrast, Sandesh is prepared from Chhana, which is an acid-coagulated curd base. This distinct processing mechanism places Sandesh firmly under the acid-coagulated product classification rather than the heat-desiccated category.

24. (C) P-2, Q-3, R-1, S-4
Paneer is manufactured through direct acid-coagulation of hot milk, while Lassi is produced by the fermentation of milk using lactic starter cultures. Peda is derived from Khoa, which undergoes extensive heat-desiccation to concentrate milk solids. Finally, Makhan is produced through the mechanical churning of cream, utilizing fat-concentration principles to separate butterfat from buttermilk.

25. (B) Fermented and concentrated
When a dairy product relies on the combined action of biological lactic acid fermentation and subsequent physical moisture removal, it falls under the fermented and concentrated category. Shrikhand is a prime example of this classification, where milk is first fermented into Dahi, and then hung or pressed to drain whey, concentrating the curd.

26. (A) II, III and V
Khoa is a heat-desiccated milk solid used as the base for preparing Barfi, and Chhana is an acid-coagulated curd that forms the foundation of Rasgulla. Ghee is classified as a fat-rich dairy product. However, Dahi is a fermented product, and Shrikhand is a fermented and concentrated sweet, making the other statements incorrect.

NODIA

27. (A) It is a partially heat-desiccated and partially acid-coagulated product.
Kalakand is characterized by a unique combination of partial heat desiccation and controlled acid coagulation. During manufacturing, a small amount of acidulant is introduced to boiling milk to induce mild, partial protein aggregation, creating a distinct granular texture. This mixture

is then further desiccated with sugar, defining its dual processing classification.

28. (C) Application of mechanical pressure to the coagulum in Paneer
The primary technological difference between these two acid-coagulated products lies in the mechanical pressing stage. Paneer is placed in perforated hoops and subjected to external hydraulic or mechanical pressure to knit the curd into a firm, sliceable block. Chhana, however, is simply hung to drain gravity-bound whey, retaining a soft, crumbly texture.

29. (D) Both are heat-desiccated, but Rabri contains distinct flaky layers of clotted cream.
Rabri and Basundi are both heat-desiccated, sweetened dairy products, but they differ significantly in their final texture. Rabri is characterized by the intentional addition of individual, flaky layers of clotted cream skimmed during heating, creating a highly heterogeneous structure. Conversely, Basundi is concentrated to a smooth, uniform, and largely homogenous liquid consistency.

30. (C) Rasgulla (raw base)
The raw base of Rasgulla is prepared strictly by the acid coagulation of hot milk to obtain Chhana, which is then kneaded into balls without undergoing intense thermal desiccation. In contrast, sweets like Gulab Jamun, Milk Cake, and Kheer involve extensive heat concentration or frying, which alters the primary moisture and physical structure.

31. (C) 30%
Under the Food Safety and Standards Authority of India regulations, Khoa prepared from cow milk must contain a minimum milk fat content of thirty percent on a dry matter basis. This regulatory standard ensures that the desiccated product maintains its traditional rich sensory attributes, nutritional quality, and appropriate texture across commercial markets.

32. (C) A is true but R is false.
Preparing Danedar Khoa requires adding a tiny amount of citric acid or sour whey to boiling milk to initiate partial coagulation and create distinct grains. However, this coagulant addition is not intended to separate whey completely as in Chhana making, but rather to establish a granular structure within the concentrating milk mass.

33. (B) I and III
Dhap Khoa actually contains the highest moisture content among the variants, making it ideal for Gulab Jamun, which requires a soft texture. Danedar Khoa is characterized by a grainy, heterogeneous structure rather than a smooth, homogenous one. Therefore, the statements claiming Pindi has the highest moisture and Danedar is smooth are incorrect.

34. (C) A sweetened, heat-desiccated dairy product containing layers of clotted cream (malai)
Rabri is defined as a traditional, sweetened milk dessert produced by slowly heating milk in a shallow pan. During this thermal concentration, layers of clotted cream, or malai, are continuously skimmed off and set aside. These layers are eventually folded back into the sweetened, condensed milk, yielding a heterogeneous, highly characteristic texture.

35. (A) Specific gravity of the whey
FSSAI standards for heat-desiccated dairy products focus on parameters that define composition and quality, including total solids, maximum added sugar limits, and titratable acidity. The specific gravity of the whey is mathematically and chemically irrelevant for grading finished Basundi, as the whey is fully integrated and not separated during manufacturing.

36. (A) IV, II, I, III
Grading commercial Khoa systematically begins with drawing a representative sample from the batch. Next, immediate sensory evaluation is conducted to detect off-flavors or staleness. The sample then undergoes chemical moisture analysis in the laboratory, which finally allows for the precise calculation of milk fat on a dry matter basis to verify compliance.

37. (B) It will be highly susceptible to rapid fungal and bacterial spoilage.
Excess moisture in Khoa raises its water activity, creating an environment highly conducive to microbial proliferation. Without the protective effect of low water activity, contaminating molds, yeasts, and bacteria will grow rapidly. This accelerates spoilage, leading to off-flavors,

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visible mold growth, and a drastic reduction in the product's commercial shelf life.

38. (C) Basundi – 40-45% TS
Basundi is typically concentrated to a total solids level of forty to forty-five percent, representing a moderately thick, sweet pourable dessert. In comparison, Pindi Khoa is much more concentrated, containing seventy to seventy-five percent total solids, while Rabri contains around fifty to fifty-five percent total solids, making the Basundi pair the correct representation.

39. (D) Exact packaging artwork color
Regulatory compliance under FSSAI focuses strictly on chemical and physical parameters that ensure product purity, safety, and standard composition. While moisture content, fat on dry matter, and starch adulteration tests are legally critical to detect fraud and ensure quality, the exact color of the packaging artwork has no bearing on the chemical legality of Khoa.

40. (A) Rabri has a heterogeneous texture with malai flakes, whereas Basundi is largely homogenous.
Although both are sweetened, heat-desiccated milk products, Rabri is distinguished by its highly heterogeneous texture containing distinct flakes of clotted cream. This is achieved by periodically skinning and collecting malai during boiling. In contrast, Basundi is prepared by continuous stirring, which prevents skin formation and yields a smooth, thickened, and largely homogenous liquid.

41. (B) 60%
Food safety regulations set by FSSAI dictate that the maximum allowable moisture content in standard commercial Paneer is sixty percent by weight. Maintaining moisture below this legal threshold is essential for achieving the desired firm, sliceable texture and preventing rapid microbiological spoilage, ensuring a standardized, compliant product for retail distribution.

42. (A) P-1, Q-2, R-3, S-4
Standard Paneer must contain at least fifty percent fat on a dry basis, while low-fat Paneer is restricted to less than fifteen percent. For Chhana, FSSAI differentiates the fat requirements based on species, requiring at least forty percent fat on dry matter for cow milk Chhana and fifty percent for buffalo milk Chhana.

43. (A) FSSAI mandates a minimum of 75% moisture for standard Chhana.
FSSAI actually mandates a maximum, not a minimum, moisture limit for standard Chhana, which is typically seventy percent. High-quality Chhana must feature a soft, spongy texture and a pleasant, mild dairy aroma. A sour flavor is considered a defect, while cow milk Chhana naturally exhibits a characteristic, appealing pale yellowish color.

44. (D) I and IV
Paneer has a lower moisture content than Chhana because it is subjected to mechanical pressing, which is not applied to Chhana. Furthermore, both products must remain completely free from adulterants like starches and vegetable fats. However, Chhana is not pressed mechanically, and firming agents are restricted, validating only specific statements.

45. (D) It exhibits a tighter, firmer body and whiter appearance.
Buffalo milk is commercially preferred for Paneer manufacturing because its high calcium and casein contents facilitate the formation of a firm, cohesive protein network during coagulation. This robust structure yields a tight, sliceable body with excellent yield. Additionally, the complete absence of carotene gives buffalo milk Paneer an appealing, bright white color.

46. (C) It fails FSSAI standard requirements for both moisture and fat.
Standard Paneer must comply with strict FSSAI requirements, which mandate a maximum moisture content of sixty percent and a minimum fat on a dry matter basis of fifty percent. A batch containing sixty-five percent moisture and forty-five percent fat on dry matter fails to meet both of these legal regulatory standards.

47. (C) A is true but R is false.
Chhana intended for Rasgulla preparation must possess a soft, smooth texture to ensure the sweets can expand and retain their characteristic sponginess during boiling. However, the reason is false because high milk fat actually improves moisture retention by physically disrupting the casein network, rather than reducing the water-holding capacity of the proteins.

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48. (D) Lactose – 15-20%
During the acid coagulation and subsequent whey drainage of Chhana, the vast majority of water-soluble lactose is washed away with the whey. Consequently, the residual lactose content in fresh Chhana is extremely low, typically around two to three percent, making the assertion of a fifteen to twenty percent lactose concentration highly incorrect.

49. (A) Chhana and related coagulated milk products
Under national food safety regulations, Paneer is formally classified within the broader category of Chhana and related coagulated milk products. This grouping recognizes that both products share a fundamental manufacturing principle, which involves the direct acid coagulation of hot milk, distinguishing them from ripened, enzymatically curdled cheeses or fermented dairy foods.

50. (C) 70-85°C
To achieve the optimal textural and physical qualities of Paneer, milk is typically coagulated within a temperature range of seventy to eighty-five degrees Celsius. This temperature range ensures proper aggregation of the proteins, creating a cohesive, firm, and sliceable curd matrix that retains the appropriate amount of moisture without becoming rubbery.

51. (C) 20-22 kg
Standardized buffalo milk with six percent fat and nine percent solid-not-fat contains approximately fifteen percent total solids. During Paneer manufacturing, most of the fat and proteins are recovered along with retained moisture. Consequently, one hundred liters of this milk typically yields approximately twenty to twenty-two kilograms of fresh, high-quality Paneer.

52. (D) I, III and IV
Pre-heating milk denatures whey proteins, allowing them to co-precipitate with casein and increase Paneer yield. Homogenization of fat also enhances yield by preventing fat loss in whey, while coagulation at a lower pH of five point four, rather than six point five, optimizes curd formation. Thus, the corresponding statements are incorrect.

53. (B) Increases yield by incorporating denatured whey proteins into the casein matrix
Subjecting milk to ultra-high temperature processing induces extensive thermal denaturation of whey proteins, especially beta-lactoglobulin. These denatured whey proteins chemically complex with kappa-casein on the micelle surfaces. When the milk is coagulated, these whey proteins precipitate along with the casein, thereby increasing the total solids recovery and Paneer yield.

54. (B) III, I, II, IV
To determine fat recovery in Khoa, the process begins by calculating the total fat mass in the starting milk. Next, the weight and fat percentage of the produced Khoa are measured to determine the total fat mass in the final product. Finally, the Khoa fat mass is divided by the initial milk fat mass and multiplied by one hundred.

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55. (D) Coagulating the milk at exactly 80°C
Coagulating milk at exactly eighty degrees Celsius is an optimal processing condition that ensures proper protein aggregation and moisture retention, thereby maximizing Chhana yield. Conversely, factors like using over-aged, highly acidic milk, excessive agitation, or highly diluted acidulants lead to fine curd particles escaping into the whey, which significantly reduces the final yield.

56. (D) P-2, Q-1, R-3, S-4
Calculating Khoa yield efficiency relies on the ratio of total solids in milk to those in the product. Paneer yield represents the recovery of casein, denatured whey proteins, and fat. Basundi is defined by a specific concentration ratio, while Sandesh yield estimation is heavily dependent on added sugar and the fat content of Chhana.

57. (B) Khoa yield strictly equals the total solids of milk plus an average of 30% retained moisture.
The theoretical yield of Khoa is directly determined by the total solids present in the starting milk, as practically all solids are recovered, plus the thirty percent average moisture retained in the final product. This yield is mathematically higher for buffalo milk due to its superior initial total solids compared to cow milk.

58. (B) Ambient humidity in the processing hall
Calculating the pure total solids recovery of Paneer requires knowing the total mass of solids entering via the milk and the mass of solids retained in the product. This calculation relies on milk weight, milk total solids, and Paneer total solids. The ambient humidity of the processing hall has no mathematical impact on this recovery.

59. (A) Buffalo milk yields a higher percentage (approx. 20-22%) due to higher initial TS, whereas cow milk yields approx. 15-17%.
Buffalo milk naturally contains a higher concentration of fat, casein, and minerals compared to cow milk, representing superior initial total solids. Consequently, when processed under identical conditions, buffalo milk yields a higher percentage of Chhana, typically around twenty to twenty-two percent, whereas cow milk yields approximately fifteen to seventeen percent of finished product.

60. (C) The percentage of a specific milk constituent successfully retained in the final product compared to the initial milk
In the dairy manufacturing sector, the recovery rate is defined as the percentage of a specific milk constituent, such as fat or protein, that is successfully transferred and retained in the final product. Monitoring this efficiency parameter is critical for assessing processing yields, minimizing manufacturing losses, and optimizing overall plant profitability.

61. (D) Immunoglobulins
Among the various whey proteins present in milk, immunoglobulins are the most thermolabile, meaning they possess the lowest resistance to heat-induced denaturation. When milk undergoes intense thermal processing, immunoglobulins denature first at relatively low temperatures, followed by bovine serum albumin, beta-lactoglobulin, and finally, the most heat-resistant major whey protein, alpha-lactalbumin.

62. (A) Both A and R are true and R is the correct explanation of A.
Coagulating milk at a pH around five point four rather than the isoelectric point of casein ensures optimal moisture retention. At this higher pH, the casein network remains sufficiently open to entrap water and denatured whey proteins, which coprecipitate due to high thermal treatment, yielding a softer and more desirable texture in Chhana.

63. (B) I and II
Intense thermal treatment of milk disrupts the protective kappa-casein layer on the micelle surface, exposing reactive sites that increase aggregation. Concurrently, reducing the pH of milk solubilizes colloidal calcium phosphate, transferring it into the serum phase and destabilizing the micellar structure. Severe cooling, however, does not irreversibly fuse the casein micelles.

64. (D) It will have a lower protein content due to the co-precipitation of denatured whey proteins with micellar casein.
Subjecting milk to severe pre-heating prior to acid coagulation induces the denaturation of whey proteins, enabling them to chemically bind with kappa-casein. Consequently, during subsequent acid coagulation, these denatured whey proteins co-precipitate with the casein micelle network, leaving a lower concentration of residual protein in the separated whey.

65. (A) The naturally occurring dissolved oxygen level in milk
The kinetics of rapid acid coagulation in hot milk are governed by temperature, acidulant type and concentration, and the physical agitation speed, which dictate how quickly casein micelles destabilize and aggregate. The dissolved oxygen level in the milk is a gaseous parameter that does not influence the ionic or physical mechanisms of protein coagulation.

66. (C) II, I, IV, III
The sequence of events during acid coagulation begins with the addition of the acidulant. This introduction lowers the pH, neutralizing the negative charge on the kappa-casein. Concurrently, the colloidal calcium phosphate solubilizes into the serum. Deprived of electrostatic repulsion and structural calcium, the destabilized casein micelles aggregate to form a visible coagulum.

67. (A) Casein micelle aggregation – Formation of a solid coagulum in Chhana
The aggregation of destabilized casein micelles under acidic and thermal conditions is the fundamental physicochemical process that drives the formation of a solid protein coagulum

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in Chhana. While whey protein denaturation actually increases Paneer yield, and lactose crystallization can cause grittiness, the association of casein micelles is directly responsible for the cohesive structure.

68. (D) Release of volatile sulfhydryl (-SH) groups from denatured whey proteins
The characteristic cooked flavor that develops during the initial heat desiccation of milk is primarily caused by the thermal denaturation of whey proteins, particularly beta-lactoglobulin. This high-temperature treatment exposes and releases volatile sulfhydryl groups containing sulfur. These active compounds impart the distinct cooked, rich, and slightly sweet flavor profile associated with fresh Khoa.

69. (B) Decrease the temperature of the milk at the time of acid addition
An excessively hard and rubbery Paneer texture occurs when milk is coagulated at too high a temperature, which promotes rapid, tight protein cross-linking and excessive moisture expulsion. To resolve this defect and obtain a softer coagulum, the operator should decrease the temperature of the hot milk slightly before introducing the acidulant solution.

70. (C) Calcium bridges play no role in the structural integrity of the Paneer matrix.
Calcium bridges play an indispensable, structurally vital role in maintaining the integrity and firmness of the Paneer protein matrix. During coagulation, calcium ions form ionic cross-links between casein molecules, stabilizing the curd network. Asserting that calcium bridges play no role is chemically incorrect, as they directly dictate the elastic, cohesive texture of Paneer.

71. (D) Reducing sugars and amino groups of proteins
The Maillard reaction is a non-enzymatic browning cascade initiated by a chemical reaction between the carbonyl group of a reducing sugar, such as lactose, and the nucleophilic amino group of an amino acid or protein, particularly lysine. This reaction occurs extensively during the high-temperature concentration and cooking of sweetened traditional dairy products.

72. (B) P-2, Q-1, R-4, S-3
Maillard browning is a reaction between reducing sugars and amino groups, such as lactose and lysine. Caramelization requires high temperatures to degrade sugars independently. Lipid oxidation is a degradative process leading to rancid off-flavors rather than browning. Finally, Strecker degradation occurs during advanced Maillard stages, generating highly complex volatile aroma compounds.

73. (B) The intensity and duration of the thermal processing
The rate and extent of Maillard browning in heat-desiccated milk products are primarily determined by the intensity and duration of the thermal processing. Applying higher temperatures for longer periods accelerates the kinetic rate of non-enzymatic browning reactions between lactose and milk proteins, allowing manufacturers to control the visual color and flavor development of sweets.

74. (C) I, II and IV
Caramelization requires temperatures far exceeding standard pasteurization to degrade sugars, while Maillard browning is entirely non-enzymatic, requiring only heat. Additionally, diacetyl is generated via fermentation, not thermal desiccation. Because high moisture content does inhibit the later stages of browning, the other statements are incorrect, identifying the correct combination of false assertions.

75. (A) Khoa possesses rich, nutty, and caramelized notes; Chhana has a bland, slightly acidic, and fresh dairy flavor.
The distinct processing methods of Khoa and Chhana produce contrasting flavor profiles. Khoa undergoes intensive, prolonged thermal concentration, promoting Maillard browning and caramelization that yield rich, nutty, and caramelized notes. In contrast, Chhana is produced by rapid acid coagulation and whey drainage with minimal heating, resulting in a mild, slightly acidic, and fresh dairy flavor.

76. (C) Loss of essential amino acids, particularly lysine
Excessive Maillard browning in traditional milk sweets leads to a significant reduction in nutritional quality. This occurs because the primary amino groups of proteins, particularly the essential amino acid lysine, are chemically bound and consumed during the initial reaction stages. Consequently, these amino acids become

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biologically unavailable, lowering the overall protein quality of the product.

77. (D) A non-enzymatic, heat-induced degradation and dehydration of sugars
Caramelization is chemically defined as a non-enzymatic thermal reaction that occurs when sugars are heated to high temperatures in the absence of nitrogenous compounds. This process involves the pyrolytic degradation, dehydration, and isomerization of saccharides, leading to the formation of complex polymeric pigments and volatile compounds that impart characteristic sweet, burnt aromas and brown colors.

78. (C) Amadori rearrangement products
The early stages of the Maillard reaction involve the condensation of a reducing sugar with an amine to form an unstable Schiff base. This intermediate chemical structure quickly undergoes a spontaneous isomerization known as the Amadori rearrangement. The resulting Amadori rearrangement products serve as the critical precursors for subsequent dehydration and fragmentation reactions.

79. (B) Melanoidins – Colorless compounds that impart intense sweetness
Melanoidins are actually complex, nitrogenous brown polymers formed during the final stage of the Maillard reaction, and they are responsible for the dark brown color of heavily desiccated dairy sweets. Because they are intensely colored pigments rather than colorless, sweet compounds, the pair describing them as colorless and sweet is chemically incorrect.

80. (D) Prolonged thermal desiccation and extensive Maillard chemical reactions
The distinctive deep brown color and rich flavor profile of Mathura Peda are developed through prolonged thermal desiccation. During this intensive heating process, the milk solids and added sugars undergo extensive Maillard browning and caramelization reactions. These non-enzymatic chemical pathways synthesize melanoidin pigments and complex aroma compounds, creating the traditional characteristics of this sweet.

81. (A) Prevents burn-on and allows continuous, uniform thermal desiccation
Scraped Surface Heat Exchangers are highly advantageous for industrial Khoa production because they feature rotating blades that continuously scrape the heating walls. This mechanical action prevents localized overheating and product burn-on, ensuring rapid, uniform heat transfer. Consequently, it allows for continuous, high-efficiency thermal desiccation while maintaining a highly consistent, high-quality product.

82. (C) I, II and IV
Barfi is made by heating Khoa with sugar, while Peda involves kneading and desiccation for a firmer body, and adding particulate ingredients disrupts the continuous protein-fat matrix. Conversely, Kalakand requires a granular texture achieved via mild acid addition, and granularity in Danedar Khoa is driven by protein aggregation, making the third and fifth statements incorrect.

83. (A) It acts as a humectant, depressing water activity and facilitating a smooth, set texture.
Adding sugar at the final stage of Khoa desiccation during Barfi manufacturing allows the sugar to dissolve in the remaining water. The sugar acts as a humectant, significantly depressing the water activity of the system. This chemical binding of water facilitates a smooth, cohesive, and properly set solid texture upon cooling.

84. (D) The physical and thermal manipulation of the product matrix to achieve desired organoleptic chewiness, granularity, or smoothness
Texturization in industrial dairy processing refers to the systematic physical, thermal, and mechanical manipulation of the food matrix. By carefully controlling heating, agitation, acid addition, and kneading, processors alter the structural state of proteins and fats. This allows them to achieve specific, desired organoleptic qualities, such as characteristic chewiness, granularity, or smoothness.

85. (B) It relies on vigorous, continuous manual scraping in a shallow iron pan to prevent scorching.
The traditional halwai method of preparing Khoa relies on boiling milk in a shallow iron pan, or karahi, over an open fire. To prevent localized scorching and burning of milk solids on the hot metal surface, the operator must perform vigorous, continuous manual scraping and stirring using a flat-bladed metal spatula throughout the concentration process.

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86. (C) A minute amount of alum (phitkari) or citric acid
In traditional Kalakand preparation, the characteristic granular texture is achieved by adding a minute amount of an acidulant, such as alum or citric acid, to the boiling milk. This minor acidification destabilizes a portion of the casein micelles, inducing controlled, partial protein aggregation that forms soft, distinct grains within the concentrating milk mass.

87. (D) Conventional methods yield products with highly standardized moisture contents batch after batch.
Conventional, manual methods of Khoa preparation rely heavily on the skill and subjective judgment of the operator, which often leads to significant batch-to-batch variations in moisture content and quality. In contrast, modern industrial processing utilizes automated equipment and standardized controls, making the assertion that conventional methods yield highly standardized moisture contents incorrect.

88. (A) Allowing the rapid, uncontrolled crystallization of lactose
To ensure a smooth, non-gritty texture in industrial Barfi, processors must avoid rapid, uncontrolled crystallization of lactose. When lactose crystallizes quickly and without control, it forms large, sharp crystals that impart an undesirable sandy mouthfeel. Therefore, controlling the cooling rate and sugar state is essential to maintain a smooth, high-quality product.

89. (B) Peda – Firm, kneaded, heavily desiccated structure possessing a smooth to slightly grainy bite
Peda is characterized by a firm, cohesive, and heavily desiccated structure obtained through controlled cooking and intensive kneading of Khoa with sugar. This process yields a compact, shapeable dough with a smooth to slightly grainy bite. Other options mischaracterize Kalakand as smooth, Peda as excessively dry and crumbly, or Milk Cake as pourable.

90. (B) Copper possesses superior thermal conductivity, reducing localized burning.
Copper pans were historically favored for traditional open-pan milk concentration because copper possesses exceptionally high thermal conductivity. This physical property ensures rapid and highly uniform heat distribution across the pan surface, which minimizes the risk of localized hot spots. Consequently, it reduces the scorching and burning of milk solids during intense heating.

91. (A) Separation of whey, hooping of the curd, and mechanical pressing
In commercial Paneer manufacturing, the standard processing sequence immediately following milk coagulation begins with separating the hot whey from the curd. The warm, drained curd is then quickly transferred into perforated metal hoops lined with clean cloth. Finally, the hoops are subjected to mechanical pressing to knit the curd into a solid block.

92. (C) Sour whey is highly preferred in industrial Paneer making for strict standardization.
Sour whey is difficult to standardize due to its highly variable acidity and microbial load, making it poorly suited for modern, high-throughput industrial Paneer manufacturing where consistent quality is paramount. Instead, industrial processors prefer food-grade citric or lactic acid solutions, which allow for precise control over pH, coagulation kinetics, and product uniformity.

93. (D) Decrease the coagulation temperature slightly (e.g., from 85°C to 70°C)
An excessively hard, dry, and rubbery Paneer texture is caused by rapid protein aggregation and intense moisture expulsion at high temperatures. To resolve this quality issue, the dairy plant should decrease the coagulation temperature slightly. Coagulating at a lower temperature slows down protein cross-linking, which helps retain more moisture within the curd matrix.

94. (C) Pressing under chilled water – Firm, well-knit Paneer blocks with closed texture
Applying mechanical pressing while the Paneer blocks are immersed in chilled water, or immediately chilling the pressed blocks, helps solidify the entrapped milk fat and compacts the protein matrix. This dual action enhances the structural integrity of the curd, producing firm, well-knit blocks with a desirable, closed texture suitable for slicing.

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95. (B) Cools the product, solidifying fat and compacting the protein matrix to impart firmness and sliceability.
Dipping freshly pressed, warm Paneer blocks into chilled water serves a vital technological function. The low temperature rapidly cools the product, which solidifies the emulsified milk fat and promotes the compaction of the hydrated casein matrix. This physical conditioning imparts the characteristic structural firmness, elasticity, and clean sliceability required for commercial retail.

96. (D) Subjecting the coagulum to extreme hydraulic pressure
Subjecting the coagulum to extreme hydraulic pressure should be avoided when manufacturing high-quality Chhana, as Chhana requires a soft, spongy, and moist texture to make premium sweets. Excessive mechanical pressure expels too much moisture and damages the delicate protein network, making the final curd far too dry, hard, and unsuitable for kneading.

97. (A) Paneer requires structural pressing to form cohesive blocks, whereas Chhana only requires whey drainage to form a loose dough.
The industrial processing of these two acid-coagulated products differs significantly in their post-coagulation handling. Paneer must be subjected to active mechanical pressing in hoops to compact the curd into solid, sliceable blocks. In contrast, Chhana is simply hung or drained by gravity to remove free whey, retaining a soft, crumbly, and easily kneadable dough.

98. (C) The filling of whey-drained curd into specialized metal molds lined with clean muslin cloth to shape the final block
Hooping is a key step in Paneer manufacturing that involves transferring the warm, whey-drained curd into specialized metal or plastic molds, known as hoops. These hoops are lined with clean muslin or cheesecloth, which facilitates further drainage while holding the curd together under mechanical pressure to shape it into a cohesive, standardized block.

99. (A) Hot citric acid solution (1-2%)
Continuous industrial Chhana-making machines widely utilize a hot, dilute citric acid solution, typically at a concentration of one to two percent, as the primary acidulant. This organic acid provides a clean, neutral flavor profile, allows for precise dosing, and ensures rapid, uniform coagulation of the flowing milk stream under controlled processing conditions.

100. (B) 5.3 - 5.5
The optimum pH range for coagulating milk in industrial Paneer manufacturing is five point three to five point five. Acidifying the milk to this specific range neutralizes casein charges sufficiently to induce rapid aggregation while maintaining enough hydration and mineral linkages. This balance ensures a cohesive, elastic, and properly textured curd block.

101. (B) Streptococcus thermophilus and Lactobacillus delbrueckii subsp. bulgaricus
Manufacturing traditional sweetened Dahi, such as Mishti Doi, on a commercial scale requires a thermophilic starter culture blend containing Streptococcus thermophilus and Lactobacillus delbrueckii subspecies bulgaricus. These lactic acid bacteria work synergistically at elevated incubation temperatures, rapidly producing the desired acidity, firm curd structure, and characteristic mild, clean flavor profile.

102. (C) Gulab Jamun – Paneer
Gulab Jamun is traditionally and commercially manufactured using a Khoa base, specifically Dhap Khoa, which provides the necessary richness and cohesive structure when blended with flour. Because it is not made from a Paneer base, the pair linking Gulab Jamun to Paneer is incorrect, unlike Sandesh, Rasgulla, and Shrikhand which are correctly mapped.

103. (D) Inadequate thermal treatment of milk or insufficient physical removal of whey during the Chakka formation step occurred.
Syneresis, or whey separation, in commercial Shrikhand is a physical defect that typically results from processing deficiencies. If the starting milk receives inadequate heat treatment, whey proteins fail to denature and bind water. Alternatively, if the fermented curd is not pressed sufficiently during Chakka preparation, excess free water remains, leading to syneresis during storage.

104. (A) A Chhana-based, non-fermented, partially desiccated sweet
Sandesh is classified as a Chhana-based, non-fermented, and partially desiccated traditional sweet. It is manufactured by cooking fresh,

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unfermented Chhana curd with sugar over low heat, which partially reduces the moisture content. The warm, sweetened mass is then flavored and molded into various traditional shapes, yielding a soft, cohesive, and melt-in-mouth texture.

105. (B) The addition of active lactic starter cultures to the syrup
Optimizing the continuous industrial production of Rasgulla requires controlling the Chhana kneading intensity, sugar syrup concentration, cooking temperature, and initial milk fat percentage. Adding active lactic starter cultures to the sugar syrup is technologically irrelevant, as Rasgulla syrup is a hot, concentrated sucrose solution designed solely for cooking and sweetening, not biological fermentation.

106. (B) The prepared spherical dough balls are deep-fried at controlled oil temperatures before being soaked in hot sugar syrup.
The commercial manufacturing of Gulab Jamun involves blending Khoa with wheat flour and water to form a smooth, cohesive dough. This dough is portioned and rolled into spherical balls, which are deep-fried in hot oil or ghee at controlled temperatures. Once golden brown, the fried balls are transferred to hot sugar syrup to soak.

107. (A) It ensures a highly uniform distribution of sugar and a smooth, homogenous texture without manual inconsistencies.
Utilizing industrial mechanized kneading systems in Sandesh manufacturing offers significant technological benefits. These automated systems subject the Chhana and sugar mixture to highly consistent shear forces, ensuring a completely uniform distribution of ingredients. This precise mechanical action eliminates the variability of manual hand-kneading, yielding a consistently smooth, homogenous, and premium product texture.

108. (C) Chakka
In traditional dairy terminology, the intermediate, concentrated yogurt base used to manufacture Shrikhand is known as Chakka. Chakka is prepared by draining the whey from fresh Dahi, typically by hanging the fermented curd in muslin cloth bags. This physical concentration process yields a thick, smooth, and highly cohesive lactic acid curd base.

109. (D) The process strictly requires a saturated 80° Brix syrup from the very beginning of the boiling phase.
Boiling Rasgulla balls requires a moderately dilute sugar syrup, typically around fifty degrees Brix, at the start of the boiling phase. Utilizing an excessively concentrated eighty degrees Brix syrup from the beginning would exert high osmotic pressure, causing the balls to shrink and harden. Therefore, the assertion of requiring a saturated eighty Brix syrup is incorrect.

110. (C) Utilize milk with an elevated total solids content (e.g., by adding skim milk powder) and heat it to 90°C for 10 minutes prior to inoculation.
To produce a set Dahi with a highly viscous, firm texture without artificial additives, manufacturers should increase the milk's total solids. Adding skim milk powder reinforces the protein network. Additionally, heating the milk to ninety degrees Celsius denatures the whey proteins, enabling them to bind water and construct a robust, stable acid-coagulated curd.

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111. (B) Rasgulla – Highly spongy, porous, and very syrupy
Rasgulla is defined by its highly spongy, porous, and syrupy nature, which allows the sweet to absorb and retain sugar syrup within its protein matrix. Other choices represent incorrect pairings because Khoa is sweet and nutty rather than sour, Paneer is firm and elastic rather than sweet, and Shrikhand is sweet, smooth, and semi-solid.

112. (D) Causes hydrolytic lipid rancidity, directly resulting in distinct soapy, metallic, and bitter off-flavors.
An elevated concentration of free fatty acids in milk lipids leads to significant organoleptic degradation in dairy products. This accumulation indicates that active lipolytic enzymes have broken down triglycerides, causing hydrolytic lipid rancidity. Consequently, this chemical spoilage directly imparts highly undesirable soapy, metallic, and bitter off-flavors, rendering the traditional sweets unpalatable.

113. (A) High-Performance Liquid Chromatography (HPLC)
High-Performance Liquid Chromatography is an analytical technique used to separate, identify, and quantify individual chemical compounds,

such as sugars, organic acids, or vitamins, in a mixture. It does not measure physical, mechanical, or rheological properties. Conversely, methods like Texture Profile Analysis, penetrometry, and shear rheometry are standard tools for analyzing product texture.

114. (C) Paneer exhibits higher hardness and chewiness values compared to Chhana.
Under instrumental texture profile analysis, Paneer displays significantly higher hardness, chewiness, and gumminess values compared to fresh Chhana. This mechanical difference arises because Paneer is subjected to active mechanical pressing, which expels free whey and knits the proteins into a dense block. Chhana remains a soft, high-moisture, and loosely aggregated gravity-drained curd.

115. (A) The rate at which a deformed sample returns to its original shape and size after the deforming force is removed
During Texture Profile Analysis of dairy products, springiness is defined as the physical ability of a deformed food sample to recover its original shape and height after the first compressing force is removed. It is mathematically calculated as the ratio of the sample height recovered during the second compression cycle to the initial deformation distance.

116. (D) Pseudoplastic (shear-thinning) behavior with semi-solid consistency
High-quality Shrikhand exhibits a characteristic pseudoplastic rheological profile where the apparent viscosity decreases under increasing shear strain. This shear-thinning behavior ensures a smooth mouthfeel and easy spreadability during consumption, while the underlying semi-solid consistency maintains the product's structural integrity, shape retention, and pleasant body characteristics during handling and portioning.

117. (C) The 100-point modified ADSA score card system
Sensory evaluation of traditional Indian dairy products frequently utilizes a modified version of the hundred-point American Dairy Science Association scorecard system. This standardized approach systematically evaluates crucial organoleptic attributes such as flavor, body, texture, color, and appearance, ensuring consistent quality control and objective comparative analysis across different commercial batches.

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118. (B) Soft, slightly spongy body, free from central lumps, with uniform syrup absorption
Premium quality Gulab Jamun requires a soft and uniform texture throughout the sweet, characterized by a slightly spongy body that absorbs sugar syrup evenly. The absence of a hard central core or unhydrated lumps is crucial for achieving the desired mouthfeel, ensuring the product melts smoothly during consumption without any structural resistance.

119. (D) Cohesiveness – Measured exclusively by a viscometer
Cohesiveness represents the strength of internal bonds within a food matrix and is determined instrumentally using a texture profile analyzer during double compression cycles. A viscometer is designed to measure the flow resistance and viscosity of liquid or semi-solid fluids, making it entirely unsuitable for measuring the cohesive properties of solid foods.

120. (A) The Barfi will be crumbly and prone to breaking apart easily in the mouth.
Cohesiveness measures the ability of a food product to hold its structural integrity together under stress. A low cohesiveness value in Barfi indicates weak internal bonding among the constituents, directly translating to a crumbly sensory texture that easily disintegrates, fractures, and breaks apart when handled or chewed in the mouth.

121. (C) Microbiological defect
Mold growth on the surface of Khoa is classified as a microbiological defect because it is caused by the proliferation of fungal microorganisms. This biological contamination typically arises from poor post-processing hygiene, inadequate packaging, or improper storage conditions, leading to visible surface mycelia growth that compromises safety, quality, and shelf life.

122. (A) Irradiating the product to destroy bacterial spores
Lactose crystallization in Rabri is a physical phenomenon influenced by cooling rates, sugar levels, and seed crystals. While controlling these physical factors helps manage lactose crystal size, irradiating the product is a microbiological sterilization technique designed to destroy

bacterial spores and does not influence or prevent the physical process of sandiness crystallization.

123. (D) It refers to the expulsion of whey from the protein network due to physical or thermal shock.
Syneresis in fermented milk products like set Dahi is a physical defect characterized by the spontaneous or induced expulsion of whey from the gelled casein network. This separation typically occurs when the protein matrix contracts under physical vibration, temperature fluctuations, excessive acidity, or structural disruption of the gel network during storage.

124. (B) It prevents the rapid growth of psychrotrophic bacteria and delays the development of sourness.
Maintaining a strict cold chain during Paneer storage is essential for suppressing the metabolic activity of spoilage microorganisms, especially psychrotrophic bacteria. Cold temperatures significantly slow down microbial proliferation and enzymatic activity, thereby preventing rapid souring, surface slime formation, and off-flavor development, which ultimately extends the overall shelf life.

125. (C) Copper or iron residues from processing equipment
Oxidized or metallic off-flavors in fat-rich traditional dairy products are caused by lipid peroxidation, which is highly catalyzed by trace heavy metals. Copper and iron residues originating from processing equipment act as powerful catalysts that accelerate the homolytic cleavage of hydroperoxides, leading to the rapid formation of undesirable volatile aldehydes and ketones.

126. (D) A spongy texture is considered a severe structural defect in Rasgulla.
Sponginess is a vital quality characteristic of premium Rasgulla rather than a structural defect, as it allows the sweet to absorb and retain sugar syrup effectively while maintaining elastic resilience. Conversely, defects such as a hard core or flattening arise from improper boiling times or inadequate syrup concentrations during cooking.

127. (A) Implement strict hygiene and packaging to prevent post-process contamination
Rapid development of sour odors and surface slime on Khoa within short periods indicates high microbial activity from post-processing contamination. Implementing strict environmental hygiene, thorough sanitation of handling equipment, and utilizing protective packaging systems are the most effective interventions to prevent the introduction and growth of these spoilage microorganisms.

128. (B) Spoilage by yeast and molds in Shrikhand – Addition of permitted sorbic acid preservative
Spoilage of Shrikhand by yeasts and molds is a major shelf-life limitation due to its high moisture and sugar content. The addition of permitted sorbic acid acts as an effective antimycotic hurdle by inhibiting fungal growth, whereas improper packaging or temperature fluctuations would actively promote defects like rancidity, sandiness, or staling.

129. (B) Causes premature protein coagulation during heating, leading to a gritty texture
Utilizing sour or over-acidified milk for Khoa manufacturing lowers the heat stability of milk proteins, specifically casein. Upon heating, this acidity causes premature, rapid coagulation of the proteins before sufficient dehydration can occur, resulting in a highly disrupted, granular, and gritty texture in the finished product rather than a smooth, cohesive body.

130. (A) Homogenous, smooth melt-in-mouth texture
A homogenous, smooth, and melt-in-mouth texture is a highly desirable organoleptic attribute that indicates superior quality in traditional dairy products. In contrast, sensory defects include unpalatable traits such as intense smokey or burnt flavors, excessive cooked notes from overheating, or sour, yeasty, and fruity odors caused by microbial spoilage.

131. (C) Vacuum packaging completely removes air, whereas MAP replaces it with gasses mixtures to preserve structure.
Vacuum packaging functions by completely extracting air from the package, which can physically compress and deform delicate, porous dairy structures like Paneer. In contrast, Modified Atmosphere Packaging replaces the internal air with a tailored mixture of protective gases, maintaining the package volume and preserving the physical shape of the product.

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132. (D) Packaging incorporating scavengers or emitters in the film to interact with the internal environment
Active packaging is an innovative technology where the packaging material actively interacts with the food or internal headspace. By incorporating functional agents such as oxygen scavengers, moisture absorbers, or antimicrobial emitters directly into the film structure, this system dynamically modifies the internal conditions to inhibit degradation and significantly extend shelf life.

133. (C) Carbon dioxide
Carbon dioxide is the primary gas used in Modified Atmosphere Packaging for dairy products because of its direct bacteriostatic and fungistatic properties. Elevated concentrations of carbon dioxide dissolve in the aqueous phase of the product to form carbonic acid, which inhibits the respiration and growth of aerobic spoilage molds and yeasts.

134. (B) Thermoformed plastic cups with sealed foil lids
Thermoformed plastic cups sealed with aluminum foil lids are widely utilized for packaging semi-solid traditional dairy products like Rabri in individual portions. This packaging system offers an excellent moisture and oxygen barrier, prevents contamination, facilitates automated high-speed filling, and provides structural rigidity to protect the product during transportation and retail.

135. (D) Retort pouch packaging
Retort pouch packaging provides the most significant shelf-life extension for Khoa-based sweets at room temperature because it combines high-barrier flexible materials with in-package thermal sterilization. This commercial sterilization process destroys all vegetative pathogens and heat-resistant bacterial spores, eliminating the requirement for continuous refrigeration during distribution and storage.

136. (A) Nitrogen gas flushing – Promotes the rapid fermentation of Dahi
Nitrogen gas flushing is used in food packaging to displace oxygen, thereby preventing lipid oxidation and aerobic spoilage rather than promoting lactic acid fermentation in Dahi. In contrast, oxygen scavengers, moisture absorbers, and antimicrobial films represent correct pairings that target fat oxidation, crispness retention, and surface microbial inhibition, respectively.

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137. (C) The Paneer may absorb CO_2, causing a slightly acidic surface flavor and package collapse.
Utilizing a hundred percent carbon dioxide in a packaging system can lead to challenges because the gas is highly soluble in the moisture and fat of Paneer. Rapid absorption of carbon dioxide into the product matrix lowers the headspace pressure, potentially causing package collapse, while also generating a slightly acidic surface flavor.

138. (A) Rigid, thermally processed packaging
Packaging Rasgulla in hermetically sealed tin cans falls under the category of rigid, thermally processed packaging. The metal can provides a robust, impermeable barrier that undergoes post-sealing commercial sterilization in retorts, protecting the high-moisture sweet from light, gas, moisture transfer, and microbial contamination over extended storage periods.

139. (D) The precise optical transparency and gloss of the outer product label
Designing a modified atmosphere packaging system requires optimizing critical physical properties such as oxygen and water vapor transmission rates of the film, along with the precise internal gas mixture. The optical transparency and gloss of the outer marketing label are purely aesthetic factors and do not influence the protective barrier performance.

140. (B) It can deform soft, aerated products due to high physical vacuum pressure.
Vacuum packaging is highly effective for dense products but can cause severe structural damage to soft, aerated, or delicate sweets. The application of high negative physical pressure during air extraction compresses the product matrix, leading to structural deformation, loss of characteristic sponginess, and expulsion of free syrup or moisture.

141. (C) They offer convenience, product standardization, and extended shelf life at room temperature.
Formulating instant dry dessert mixes offers significant technological advantages by reducing water activity to levels that prevent microbial growth. This low moisture content ensures a highly extended shelf life at room temperature,

while providing consumers with convenient, rapid preparation, and highly standardized product quality across different locations and seasons.

142. (D) Skim milk powder and vegetable fat
Commercial instant Gulab Jamun mixes utilize a blend of skim milk powder and vegetable fat as the base ingredients to replicate the functional composition of traditional Khoa. Upon hydration and mixing, this combination provides the necessary proteins and lipids required to form a cohesive, smooth dough with proper frying and melting characteristics.

143. (A) Convenience mixes never require any chemical leavening agents.
Convenience dessert mixes frequently require chemical leavening agents like sodium bicarbonate to ensure proper expansion and porosity during cooking or frying. Other processing parameters, such as precise reconstitution instructions, addition of functional emulsifiers for fat dispersion, and powder agglomeration techniques, are critical to achieving the desired product consistency and solubility.

144. (B) Insufficient functional milk protein or inappropriate binder ratios
The failure of an instant Rasgulla mix to form a cohesive, elastic dough during reconstitution is primarily linked to inadequate levels of functional milk proteins or incorrect binder ratios. Functional proteins are essential for building the cohesive gel network upon hydration, which holds the matrix together and prevents disintegration during cooking.

145. (B) Skim Milk Powder – Provides the primary protein gel matrix
Skim milk powder is the core structural ingredient in instant dairy mixes, providing the vital casein and whey proteins that build the cohesive protein gel matrix. Conversely, sodium bicarbonate acts as a leavening agent, citric acid functions as an acidulant, and maida serves as a binder rather than altering fat content.

146. (A) Causes caking, lumping, and non-enzymatic browning, making the mix unusable
Exposing dry dessert mixes to high ambient humidity leads to moisture absorption, which initiates several physical and chemical degradations. This moisture uptake causes powder particles to stick together, resulting in caking and lumping, while simultaneously mobilizing lactose and amino acids to accelerate undesirable non-enzymatic Maillard browning reactions during storage.

147. (C) The absolute necessity of using distilled water only
Reconstitution parameters printed on convenience mix packages typically specify the exact volume of liquid, liquid temperature, and dough resting time necessary to achieve optimal hydration. Specifying the absolute necessity of using distilled water is highly impractical and unnecessary for domestic preparation, as standard potable tap water or milk is sufficient.

148. (D) Instant mix products typically exhibit a denser, more doughy, and slightly less creamy mouthfeel than Khoa.
Gulab Jamun manufactured from instant dry mixes containing cereal binders usually exhibits a denser, more doughy interior texture compared to traditional fresh Khoa formulations. The higher cereal-to-protein ratio and different fat distribution in dry mixes reduce the overall lubricity and creaminess, resulting in a slightly firmer and less melt-in-mouth sensory profile.

149. (C) A product processed to a degree requiring minimal further preparation before eating
Convenience food refers to any food product that has been industrially processed to a significant degree, thereby minimizing the time, effort, and preparation required by the end consumer before consumption. These products are designed for rapid preparation, portion control, ease of storage, and consistent quality under modern busy lifestyles.

150. (B) To improve moisture retention, dough binding, and final texture
Hydrocolloids are incorporated into instant dairy dessert formulations because of their exceptional water-binding and macromolecular structuring properties. Upon reconstitution, these hydrophilic polymers improve dough binding, enhance moisture retention during subsequent frying or cooking, and modify the final texture to prevent undesirable hardness or crumbly physical defects.

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151. (D) The lethality of heat treatment expressed as equivalent minutes at 121.1°C
The F_0 value in thermal processing operations represents the total heat lethality delivered to a product, mathematically expressed as the equivalent heating time in minutes at a reference temperature of 121.1 degrees Celsius. This parameter is critical for calculating and ensuring the destruction of highly heat-resistant bacterial spores.

152. (A) Rasgulla
Rasgulla is the traditional Indian dairy sweet most commonly commercialized in a canned, retort-processed format. The high-moisture sponge structure of Rasgulla, when immersed in a protective sugar syrup matrix, displays excellent thermodynamic stability that can withstand high sterilization temperatures without structural collapse or losing its characteristic texture.

153. (C) Incubation – Cooling the cans rapidly in a blast freezer
Incubation in canning operations refers to holding processed containers at specific elevated temperatures to verify commercial sterility and detect thermophilic spoilage, rather than rapid cooling in a blast freezer. Conversely, exhausting, seaming, and retorting are correctly paired with their primary technological functions of air removal, hermetic sealing, and thermal sterilization.

154. (A) The process was insufficient to destroy thermophilic spore-forming bacteria.
Flat sour spoilage in canned products is characterized by acid production without gas formation, caused by facultative anaerobic thermophilic spore-forming bacteria. This spoilage indicates that the thermal sterilization process was insufficient to destroy these highly heat-resistant spores, or that the cans were cooled too slowly and stored at warm temperatures.

155. (D) Commercial sterilization technology
Retort pouch processing of dairy sweets is primarily classified under commercial sterilization technology. This high-temperature, high-pressure thermal process is designed to destroy all pathogenic and spoilage microorganisms, including highly heat-resistant bacterial spores, within a hermetically sealed flexible pouch, allowing the food to remain completely shelf-stable at ambient temperatures.

156. (B) The exact font size of the nutritional label
Determining the required thermal lethality or F_0 value depends on physical and microbiological parameters, including initial microbial load, product pH, and matrix heat-penetration dynamics. The physical font size of the printed nutritional label is a regulatory packaging design requirement that has absolutely no impact on thermodynamic heat transfer or microbial thermal death kinetics.

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157. (C) Retorting alters the starch-casein matrix rheology, requiring careful stabilizer formulation.
Long-life canning of Kheer involves complex thermal interactions between milk proteins and rice starch. The high temperatures during retorting alter the starch-casein matrix rheology, which can lead to excessive thickening, phase separation, or starch retrogradation. Therefore, careful formulation using appropriate stabilizers is necessary to maintain a uniform, desirable consistency.

158. (D) They possess a thinner profile, allowing faster heat penetration and reducing thermal damage.
Flexible retort pouches offer a distinct technological advantage over rigid metal cans due to their much thinner physical profile. This geometry significantly reduces the distance heat must travel to reach the thermal center of the product, enabling rapid heat penetration, shortening processing times, and minimizing heat-induced sensory and nutritional damage.

159. (A) Clostridium botulinum
Commercial sterilization of low-acid canned foods, including dairy-based sweets like Gulab Jamun, primarily targets the destruction of highly heat-resistant endospores of Clostridium botulinum. This anaerobic pathogen produces a deadly neurotoxin in sealed containers, making its complete elimination the standard biological benchmark for establishing safe thermal processing schedules in canning.

160. (B) Agating retorts are never used for dairy products as they immediately cause fat churning.
Agating retorts are commonly utilized for viscous dairy products to enhance convective heat transfer and prevent localized burn-on or caramelization. In contrast, high sugar concentrations protect spores, rapid cooling prevents overcooking, and monitoring the coldest spot inside the container

is essential for confirming the overall thermal adequacy of the sterilization process.

161. (B) Hurdle technology
Formulating a dairy sweet by simultaneously applying multiple preservation parameters, such as partial desiccation, adding potassium sorbate, and nitrogen gas flushing, is a classic application of hurdle technology. This strategy coordinates gentle, non-lethal preservation factors to synergistically inhibit microbial growth and chemical degradation, maintaining quality without relying on extreme processing.

162. (A) Lowered pH – Disrupts cellular homeostasis in spoilage microbes
Lowering the pH of a food product serves as a highly effective hurdle by disrupting the transmembrane electrical potential and cellular homeostasis of spoilage microorganisms. This acidic environment forces cells to expend energy pumping protons out, which severely inhibits their metabolic activity and growth, whereas low water activity primarily restricts microbial hydration rather than damaging DNA.

163. (C) Causes a highly reducing environment, inhibiting strict aerobes like molds and bacteria.
Manipulating the redox potential through vacuum packaging removes oxygen from the internal atmosphere, creating a highly reducing environment. This oxygen depletion effectively acts as a critical hurdle that inhibits the proliferation of strict aerobic spoilage microorganisms, such as molds and pseudomonads, which require positive oxidation-reduction potentials to carry out metabolic respiration.

164. (D) Intentional contamination with spoilage yeast
Typical preservation hurdles for traditional dairy products include thermal processing, lowering water activity through sugar addition, and utilizing competitive lactic cultures. In contrast, intentional contamination with spoilage yeast is a highly detrimental event that directly causes rapid gas formation, off-flavors, and complete product spoilage rather than acting as a preservation hurdle.

165. (C) Peda relies heavily on low a_w and high sugar; Paneer relies on refrigeration and low initial microbial load.
Peda achieves ambient shelf stability by utilizing high sugar concentrations and thermal desiccation to lower its water activity, creating a highly effective preservative hurdle. Conversely, fresh Paneer possesses high moisture and neutral pH, meaning it relies strictly on rapid cooling, continuous refrigeration, and minimizing post-process contamination to limit microbial growth.

166. (B) The ratio of the water vapor pressure in food to that of pure water at the same temperature.
Water activity represents the energy state of water in a food system and is defined as the ratio of the water vapor pressure in the food matrix to that of pure water at identical temperatures. This parameter is a critical hurdle because it determines the availability of free water to support microbial metabolic reactions.

167. (D) Extremely low water activity (a_w near 0)
Ghee achieves its exceptional shelf stability at room temperature primarily through the extreme thermal desiccation process during manufacturing, which removes virtually all moisture. This intensive dehydration reduces the water activity to near zero, creating an environment that completely prevents the survival, germination, and growth of all bacterial and fungal microorganisms.

168. (A) Pathogenic bacteria and putrefactive spoilage organisms
Maintaining a low pH of approximately 4.2 to 4.4 in Shrikhand is a critical preservation hurdle that is highly effective against pathogenic bacteria and putrefactive spoilage microorganisms. These organisms are generally sensitive to acidic conditions and cannot survive or multiply, whereas certain acidophilic yeasts and molds can tolerate these low pH levels.

169. (C) Adding a permitted antimycotic and lowering the syrup pH slightly.
To extend the shelf life of high-moisture Rasgulla without retorting, a combination of hurdles is recommended. This includes adding a permitted antimycotic agent like potassium sorbate to inhibit mold growth, while slightly lowering the syrup pH. These steps work synergistically to create unfavorable conditions for spoilage organisms while preserving product texture.

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170. (A) Natamycin – Primarily inhibits Gram-negative bacteria like E. coli
Natamycin is an antifungal agent that specifically targets yeasts and molds by binding to fungal cell membrane sterols, having no activity against bacteria like Escherichia coli. Conversely, sorbic acid acts as a general antimycotic, nisin is highly effective against Gram-positive vegetative bacteria and spores, and benzoic acid serves as a regulated antimicrobial.

171. (D) The resulting coagulum will have higher mineral and whey protein content in the matrix.
Utilizing ultrafiltration to concentrate milk proteins before Chhana manufacture retains soluble minerals and whey proteins that are normally lost in the permeate. Consequently, the subsequent acid coagulation step produces a modified curd matrix with higher yield, elevated water-binding capacity, and a softer texture due to the inclusion of these hydrophilic whey proteins.

172. (B) A concentration process that removes only water from the feed
Reverse Osmosis is a high-pressure membrane separation process classified as a pure concentration technology. The dense polymeric membrane structure has a high rejection coefficient that permits only water molecules to pass through as permeate, while retaining all dissolved solutes, including lactose, minerals, proteins, and lipids, within the concentrated retentate.

173. (C) The external color of the membrane housing unit
The rejection coefficient and flux during Reverse Osmosis are governed by physical parameters such as transmembrane pressure, feed temperature, flow velocity, and turbulence across the membrane boundary. The external aesthetic color of the stainless steel or plastic housing unit is completely irrelevant and has no impact on filtration performance or thermodynamics.

174. (D) UF concentrates milk prior to fermentation, eliminating the traditional whey drainage step.
Applying ultrafiltration in Shrikhand manufacturing allows for the pre-concentration of milk proteins and fat prior to lactic fermentation. This advanced approach eliminates the traditional, labor-intensive, and unhygienic step of draining whey from the curd using hanging cloth bags, thereby increasing product yield, improving hygiene, and enabling a fully continuous commercial production process.

175. (A) It washes out lactose and soluble minerals while retaining proteins, lowering carbohydrate content.
Incorporating diafiltration alongside ultrafiltration allows for the selective washing out of low-molecular-weight solutes, primarily lactose and soluble minerals, from the retentate while retaining macromolecular proteins. This process effectively de-lactoses the milk concentrate, which is highly beneficial for manufacturing low-carbohydrate, high-protein dietetic dairy products with modified physical and chemical behaviors.

176. (B) Water, lactose, soluble salts, and non-protein nitrogen
The permeate generated during the ultrafiltration of milk contains only small, low-molecular-weight constituents that can easily pass through the membrane pores. These compounds primarily consist of water, lactose, soluble mineral salts, and non-protein nitrogen compounds, whereas larger substances like casein micelles, whey proteins, and fat globules are completely retained in the retentate.

177. (B) Membrane fouling is a minor issue that rarely affects commercial continuous runs.
Membrane fouling is a major technological challenge in commercial dairy processing that severely restricts operating flux, increases energy consumption, and requires frequent chemical cleaning cycles. In contrast, ultrafiltration improves Chhana yields by retaining whey proteins, produces smoother Paneer, and reverse osmosis pre-concentration significantly reduces the energy required for Khoa desiccation.

178. (A) The structure of malai flakes remains identical to conventional methods, but with reduced boiling time.
Pre-concentrating milk using Reverse Osmosis prior to Rabri production significantly reduces the boiling time and thermal energy required to reach the desired solids concentration. This process does not negatively affect the formation of characteristic malai flakes, which still form on the surface during heating, ensuring the sensory quality remains identical to traditional methods.

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179. (C) Reverse Osmosis (RO) – 30 to 60 bar (High pressure)
Reverse Osmosis is a high-pressure membrane technology that requires operating pressures between thirty and sixty bar to overcome the high osmotic pressure of concentrated milk solutes. In contrast, microfiltration and ultrafiltration operate at much lower pressures, typically below five bar, because they utilize larger pore sizes that offer less physical resistance.

180. (D) Causes higher water-binding, resulting in a softer texture and increased product yield.
Retaining whey proteins in Paneer through membrane ultrafiltration significantly increases the total water-binding capacity of the protein matrix. These highly hydrophilic whey proteins trap moisture within the coagulum, resulting in a softer, smoother, and less crumbly texture, while also substantially increasing the total yield of the finished product from a given volume of milk.

181. (C) Enhancing nutritional profiles by providing essential vitamins
Food hydrocolloids are added to dairy products to perform physical and rheological functions, such as preventing syneresis, modifying texture, and stabilizing fat-in-water emulsions. They are not utilized to enhance nutritional profiles through vitamin fortification, which is a separate process involving the direct addition of purified micronutrient vitamins to milk.

182. (B) Carrageenan gels by interacting with casein, while CMC thickens by binding water.
Carrageenan and carboxymethyl cellulose function differently in dairy systems due to their distinct molecular structures. Carrageenan possesses negatively charged ester sulfate groups that interact directly with the positively charged regions of casein micelles to form weak gel networks, whereas carboxymethyl cellulose acts as a thickening stabilizer primarily by binding and immobilizing free water molecules.

183. (D) A hydrophilic polymer dispersing in water to increase viscosity or form stable gels.
A hydrocolloid is a macro-molecular hydrophilic polymer that easily disperses in water to form a colloid system, increasing viscosity or forming stable gels. In dairy processing, these substances act as highly functional stabilizers, thickeners, and gelling agents, preventing phase separation and modifying sensory characteristics to ensure uniform quality during storage.

184. (A) Microcrystalline cellulose or specialized food gums
Sandiness in concentrated dairy sweets is caused by the uncontrolled growth of large lactose crystals. Adding microcrystalline cellulose or specialized food gums helps prevent this defect by increasing the viscosity of the continuous phase, which slows down molecular diffusion and limits crystal growth, maintaining a smooth texture over the storage period.

185. (C) Calcium
Sodium alginate requires the presence of divalent calcium ions to form a stable, three-dimensional gel network. This gelation occurs through an ionic cross-linking mechanism where calcium ions bind to the guluronate blocks of adjacent alginate polymer chains, forming the characteristic egg-box structure that immobilizes water and stabilizes the dairy matrix.

186. (A) Maltodextrin or specialized starches
Industrially manufactured Peda can suffer from crumbling due to moisture loss and poor binder cohesion. Adding maltodextrin or specialized starches improves the structural integrity of the sweet by binding free moisture, enhancing the cohesive properties of the milk solids, and acting as a functional matrix-builder that prevents fracturing during handling.

187. (D) Lecithin – Acts as an intensely potent artificial sweetener
Lecithin is a naturally occurring phospholipid mixture that acts as an emulsifier to stabilize fat-in-water emulsions, and it does not possess any sweetening properties. In contrast, pectin is correctly paired with gelation, guar gum with preventing syneresis in Shrikhand, and sodium citrate with stabilizing protein networks as an emulsifying salt.

188. (B) The product will have a highly porous, spongy, and expanded core upon heating.
Adding a higher proportion of chemical leavening agents like baking powder to a Gulab Jamun dry mix generates carbon dioxide gas during the cooking and frying process. This internal gas production creates a highly porous, spongy, and expanded core within the fried balls, which

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subsequently facilitates rapid and uniform absorption of the sugar syrup.

189. (C) Complex polysaccharides
Stabilizers such as locust bean gum and xanthan gum are chemically classified as complex polysaccharides. These high-molecular-weight carbohydrates consist of long chains of monosaccharide units that associate through hydrogen bonding in aqueous environments, increasing the viscosity of the liquid phase and effectively stabilizing the food matrix against syneresis and phase separation.

190. (D) Its inherent color in a completely dry, unhydrated state
When selecting a hydrocolloid stabilizer for commercial Dahi production, critical parameters include its interaction with casein micelles at low pH, its water-binding capacity, and its thermal stability during pasteurization. The dry, unhydrated color of the powder is irrelevant, as the stabilizer is fully dissolved and hydrated at very low concentrations.

191. (A) Low-fat Paneer suffers from a hard, rubbery, and dry texture without interventions.
Removing milk fat from Paneer formulations severely impacts its textural and sensory characteristics because fat acts as a plasticizer and lubricant within the protein matrix. Without interventions such as fat mimetics or increased moisture retention, low-fat Paneer exhibits a hard, rubbery, dry, and unappealing texture that lacks the typical melt-in-mouth quality.

192. (B) They mimic the creamy mouthfeel of milk fat without adding the high lipid calories.
Microparticulated whey proteins undergo a specialized thermal and mechanical processing treatment that shapes them into tiny, spherical particles. These micro-particles mimic the physical dimensions and behavior of homogenized milk fat globules, creating a smooth, creamy mouthfeel and lubricity in low-fat dairy formulations without contributing the high calories associated with lipids.

193. (B) Modified starches, maltodextrins, and polydextrose
Carbohydrate-based fat replacers commonly include modified starches, maltodextrins, and polydextrose. These compounds function by binding large volumes of water to form smooth, highly viscous gels that closely mimic the physical thickness, body, and lubricating mouthfeel of fats in low-fat dairy desserts, helping to mitigate the dry texture of fat reduction.

194. (A) Protein fat replacers withstand boiling paneer coagulation without denaturing.
Protein-based fat replacers are highly sensitive to thermal and acidic conditions and will undergo denaturation and aggregation during the hot acid coagulation process of Paneer making, altering their structural functionality. Conversely, carbohydrate replacers bind water effectively, helping to reduce the rubbery chewiness of low-fat formulations, though they cannot fully replicate fat-derived flavors.

195. (C) It acts as both a bulking/fat-mimetic agent and a prebiotic dietary fiber.
Inulin is a versatile ingredient in dietetic low-fat Shrikhand because of its dual technological and nutritional functionality. It acts physically as a bulking and fat-mimetic agent by binding water to replicate the creamy texture of milk fat, while also serving as a prebiotic dietary fiber that selectively stimulates beneficial gut microflora.

196. (D) Olestra – Synthetic lipid-based polyester
Olestra is a synthetic lipid-based fat substitute chemically classified as a sucrose polyester, designed to resist human enzymatic digestion while providing fat-like cooking and sensory properties. In contrast, microparticulated whey is protein-based, polydextrose is carbohydrate-based, and maltodextrin is a starch-derived carbohydrate polymer rather than a structured lipid.

197. (C) Causes a tough, dry, granular texture with compromised binding properties.
Reducing the fat content of Khoa without using fat mimetics results in a product with a hard, dry, and highly granular texture. The absence of lipids, which normally coat the proteins and provide lubrication, leads to a dense and rubbery protein network with poor cohesion and compromised binding properties during subsequent sweet preparation.

198. (B) Development of an excessively soft, flowing structure due to high fat levels
Formulating low-fat Indian dairy sweets presents challenges such as loss of creamy flavor, increased hardness of the protein matrix, and altered

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heat transfer behavior. The development of an excessively soft, flowing structure due to high fat levels is not a low-fat defect, as fat reduction inherently increases firmness and rigidity.

199. (D) Carbohydrate-based replacers are heat-stable, whereas protein-based ones may denature. During high-heat dairy applications like Khoa desiccation, carbohydrate-based fat replacers show high thermal stability and maintain their water-binding and bulking functions without degrading. In contrast, protein-based fat replacers are prone to thermal denaturation and aggregation at elevated temperatures, which can severely compromise their fat-mimicking behavior and smooth mouthfeel properties.

200. (A) Products formulated with modified nutrition profiles to meet specific dietary needs.
Dietetic traditional dairy products are foods specifically formulated with modified nutritional profiles to cater to the unique health requirements of distinct consumer groups. These modifications typically include reducing calories, fat, or sucrose, and incorporating health-promoting ingredients like dietary fibers, probiotics, or natural sugar substitutes to manage conditions like diabetes or obesity.

201. (C) Sucralose
Sucralose is an intense artificial sweetener produced by the selective chlorination of sucrose, where three hydroxyl groups are substituted with chlorine atoms. This chemical modification yields a sweetener that is approximately six hundred times sweeter than sucrose, while remaining highly stable under a wide range of temperatures and pH levels.

202. (A) Sorbitol or Polydextrose
Diabetic-friendly Barfi formulations require bulking agents like sorbitol or polydextrose to replace the physical mass, volume, and mouthfeel lost when sucrose is replaced with intense sweeteners. These ingredients provide the necessary solid bulk, aid in texture development, and maintain appropriate water activity levels without inducing rapid postprandial blood glucose spikes.

203. (D) Aspartame
Aspartame is a dipeptide sweetener that is highly sensitive to elevated temperatures, undergoing rapid thermal degradation and losing its sweetness when exposed to prolonged heat. Consequently, it is avoided in traditional dairy products that require intensive thermal processing, such as boiling sugar syrups for Rasgulla, where heat-stable sweeteners are required.

204. (B) Xylitol – Intense artificial sweetener structurally similar to aspartame
Xylitol is a sugar alcohol or polyol that provides a sweetness intensity similar to sucrose, rather than being an intense artificial sweetener structurally related to aspartame. In contrast, erythritol is a low-calorie sugar alcohol, stevia is a plant-derived high-intensity sweetener, and maltitol is a polyol with a sucrose-like sensory profile.

205. (C) The product will suffer a drastic loss of mass and body due to lack of sugar bulk.
Replacing one hundred percent of the sucrose in Kalakand with liquid Sucralose without adding a bulking agent leads to a severe loss of physical mass and body. Sucrose provides significant solid bulk and structure in traditional sweets, and its complete removal without a replacement results in a highly compromised, weak, and thin product.

206. (D) Hydrogenated carbohydrates
Sugar alcohols, or polyols, are hydrogenated carbohydrates produced by reducing the carbonyl group of saccharides to a hydroxyl group. These compounds are widely used in low-calorie and diabetic-friendly traditional sweets because they provide bulk, sweetness, and a pleasant cooling effect while being only partially digested and absorbed by the human body.

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207. (A) Its specific optical rotation value in a polarimeter
When utilizing bulking agents to replicate the functionality of sucrose in diabetic sweets, key technological properties like total solids contribution, water activity depression, and crystallization behavior must be carefully balanced. The specific optical rotation value of sucrose in a polarimeter is an analytical physical property that has no influence on product texture, stability, or mouthfeel.

208. (B) They cause gastrointestinal distress and laxative effects due to poor absorption.
Excessive consumption of sugar alcohols like sorbitol in diabetic-friendly sweets can cause

gastrointestinal discomfort and laxative effects. Because these polyols are only partially absorbed in the small intestine, they pass into the colon where they exert osmotic pressure and undergo bacterial fermentation, leading to gas, bloating, and osmotic diarrhea.

209. (B) It exhibits excellent heat stability and has a synergistic effect in sweetener blends.
Acesulfame Potassium offers a distinct advantage in traditional dairy sweet formulations due to its excellent thermal stability, allowing it to withstand high-temperature boiling and concentration processes without degrading. Additionally, when blended with other high-intensity sweeteners, it exhibits a synergistic effect that improves the overall sweetness profile and masks lingering aftertastes.

210. (A) Monk fruit extract
Monk fruit extract is a natural, high-intensity sweetener obtained from the fruit of Siraitia grosvenorii. The sweet taste is primarily derived from mogrosides, which are non-caloric compounds that can be up to three hundred times sweeter than sucrose, making it a popular natural sugar replacer in dietetic and diabetic-friendly food formulations.

211. (C) SSHE operations strictly require batch processing and cannot operate continuously.
Scraped Surface Heat Exchangers are specifically designed for continuous industrial processing of highly viscous foods and do not require batch operations. Critical operational parameters that influence heat transfer efficiency and product quality include rotor speed, the continuous scraping action to prevent surface burn-on, and the precise clearance between the blades and the cylinder wall.

212. (D) Increase the residence time or elevate jacket steam pressure to enhance thermal exposure.
If Khoa produced using a Scraped Surface Heat Exchanger lacks the characteristic cooked flavor and browning, the heat treatment must be increased. This is achieved by increasing the residence time of the milk within the cylinder or elevating the jacket steam pressure, thereby enhancing the thermal exposure necessary to promote Maillard browning reactions.

213. (C) Rotor shaft – Drives the blades to ensure continuous surface renewal and mixing
The rotor shaft is a critical engineering component of a Scraped Surface Heat Exchanger, designed to drive the scraper blades. This rotational movement ensures continuous mixing and surface renewal along the heated cylinder wall, preventing product burning and enhancing convective heat transfer, while the jacket provides heat and the pump feeds the system.

214. (B) Causes a burn-on layer, reducing heat transfer efficiency and imparting scorched flavor.
Insufficient scraper blade pressure against the internal heat transfer wall of a Scraped Surface Heat Exchanger prevents effective removal of the viscous boundary layer. This leads to the rapid formation of a fouled, burned-on product layer, which severely reduces heat transfer efficiency and imparts an undesirable scorched or burnt flavor to the concentrated Khoa.

215. (D) Ability to process continuously without any human or mechanical intervention
A Conical Vat is fundamentally designed as a batch processing vessel and does not possess the capability for continuous, automated production without human or mechanical intervention. Its engineering advantages over traditional flat-bottomed open pans include improved convective mixing, enhanced steam jacket thermal efficiency, and easier mechanical discharge of highly viscous products through the bottom apex.

216. (A) SSHE handles transitions continuously in cylinders; Conical Vat operates as a batch concentrator.
Scraped Surface Heat Exchangers and Conical Vats differ in their operational modes for industrial Khoa production. The SSHE system is designed for continuous processing, concentrating milk as it flows through heated cylinders, whereas the Conical Vat operates as a high-capacity batch system that concentrates a fixed volume of milk per cycle.

217. (C) The average duration a specific fluid element spends inside the active heat exchanger cylinder.
Residence time in the context of continuous thermal processing is defined as the average duration that a given fluid element spends inside the active heating zone of the heat exchanger cylinder. Controlling this parameter is critical for achieving consistent moisture evaporation,

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product concentration, and uniform development of cooked flavors and color.

218. (A) Stainless steel cylinder with food-grade polymer or specialized alloy blades
Modern Scraped Surface Heat Exchangers utilize high-grade stainless steel for the heat transfer cylinder to ensure excellent durability, corrosion resistance, and food safety. The scraper blades are manufactured from food-grade polymers or specialized wear-resistant alloys to prevent metal-on-metal friction damage while maintaining effective scraping action along the heated internal surface.

219. (D) The overall heat transfer coefficient and surface-to-volume ratio
Scaling up continuous milk desiccation processes from pilot to industrial scale successfully relies on maintaining a constant overall heat transfer coefficient and surface-to-volume ratio. Preserving these fundamental thermodynamic relationships ensures consistent water evaporation rates, prevents localized overheating or fouling, and yields finished product quality identical to the pilot-scale trials.

220. (B) The rotational speed of the internal scraper assembly
The rotational speed of the internal scraper assembly in a Conical Vat must be strictly controlled to prevent excessive mechanical shear damage. High shear rates can disrupt the developing protein-fat matrix of Khoa, leading to fat churning, phase separation, and a greasy, compromised texture instead of a uniform, cohesive body and smooth mouthfeel.

221. (C) Mechanized sweet-forming equipment – Roasts raw milk directly into dry powder
Mechanized sweet-forming equipment is designed for portioning, shaping, and molding dense sweet matrices, and is entirely incapable of roasting raw milk into dry powder. In contrast, continuous Chhana makers, pneumatic Paneer hoop pressing systems, and Scraped Surface Heat Exchangers are correctly paired with their primary technological functions in mechanized dairy processing.

222. (D) It will consist of finely dispersed curd particles due to high-shear mixing.
A continuous Chhana maker utilizing a highly turbulent flow regime in its coagulation section will subject the forming curd to high-shear mixing forces. This turbulence prevents the development of large, cohesive curd blocks, resulting in finely dispersed curd particles that require efficient filtration and separation systems to recover the coagulum.

223. (A) Rheological manipulation and portioning technology
Mechanized sweet-forming equipment, such as automatic encrusting machines and ball formers, is classified as rheological manipulation and portioning technology. These machines use extrusion and cutting mechanisms to divide highly viscous sweet matrices into uniform portions and shape them into consistent spherical or cylindrical geometries, ensuring high throughput and standardization.

224. (B) The exact aerodynamic drag coefficient of the external machine casing
Designing a pneumatic pressing system for industrial Paneer requires optimizing critical functional parameters, including the applied pressure per unit area, pressure duration, and mold drainage efficiency. The external aerodynamic drag coefficient of the machine casing is a fluid dynamics parameter for high-speed vehicles and has no relevance to industrial food pressing.

225. (B) They incorporate a specialized draining conveyor or rotary screen to separate hot whey.
Continuous Chhana making machines are designed to automate acid coagulation and separation. To handle large volumes efficiently, they incorporate specialized draining conveyors or inclined rotary screens that continuously separate the hot whey from the curd particles immediately after coagulation, ensuring high throughput, hygienic handling, and consistent moisture levels in the curd.

226. (A) High-speed portion control, weight standardization, and hygienic handling
Utilizing mechanized encrusting and forming equipment for traditional sweets offers key industrial advantages, including high-speed portion control, precise weight standardization, and improved hygienic handling. This mechanization minimizes direct human contact with the food, reducing post-process contamination risks while ensuring uniform size

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and appearance across large-scale commercial production batches.

227. (C) Pneumatic or hydraulic presses
Modern large-scale Paneer manufacturing facilities have largely replaced manual dead-weight systems with automated pneumatic or hydraulic pressing systems. These mechanized systems allow for the precise control and standardization of pressure and time profiles, ensuring uniform moisture expulsion, highly consistent block density, and superior textural quality across different industrial production runs.

228. (D) They are completely incapable of producing Chhana suitable for Rasgulla.
Continuous Chhana makers are highly capable of producing high-quality Chhana suitable for Rasgulla manufacturing when operational parameters such as coagulation temperature and pH are precisely controlled. These automated systems offer major benefits, including reduced labor requirements, precise acid dosing, and continuous whey recovery, making them highly efficient for industrial-scale sweet production.

229. (C) Lower the milk injection temperature or decrease the acidulant strength.
If a continuous Chhana maker produces an excessively tough and rubbery product, the rate of protein aggregation must be reduced. This is achieved by lowering the milk injection temperature or decreasing the concentration of the acidulant, which slows down curd contraction and limits syneresis, resulting in a softer, more cohesive coagulum.

230. (B) Whey conveyor – Comprises a moving mesh belt allowing rapid liquid gravity separation
The whey conveyor in a continuous Chhana maker is equipped with a moving, perforated mesh belt that facilitates rapid gravity separation of liquid whey from coagulated curd particles. In contrast, coagulation tubes do not freeze milk, Paneer molds must be perforated for drainage, and sweet formers do not require operating under high vacuums.

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CHAPTER 03

Technological Aspects of Processed Dairy Products

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2021

1. Which phospholipid fraction is quantitatively most abundant in the Milk Fat Globule Membrane (MFGM)?
(A) Phosphatidylserine
(B) Sphingomyelin
(C) Phosphatidylinositol
(D) Phosphatidylethanolamine

2003

2. The isoelectric point of the intact Milk Fat Globule Membrane (MFGM) typically falls within which pH range?
(A) 1.5 to 2.5
(B) 3.7 to 4.1
(C) 5.0 to 5.5
(D) 6.5 to 7.0

2006

3. Given below are two statements: one is labeled as Assertion (A) and the other is labeled as Reason (R).
Assertion (A): The MFGM acts as a natural emulsifier preventing the coalescence of fat globules.
Reason (R): The amphiphilic nature of polar lipids and membrane proteins lowers the interfacial tension.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2017

4. Which of the following fatty acids does NOT contribute significantly to the short-chain triglyceride profile of bovine milk fat?
(A) Arachidonic acid
(B) Butyric acid
(C) Caproic acid
(D) Caprylic acid

2013

5. Identify the correct combination of statements regarding MFGM proteins.
I. Butyrophilin is a major integral membrane protein.
II. Xanthine oxidase accounts for a significant portion of the peripheral proteins.
III. Casein micelles are the primary structural framework of the outer MFGM layer.
Which of the following represents exactly two correct statements?
(A) I and II
(B) II and III
(C) I and III
(D) I, II and III

2018

6. A decrease in the proportion of unsaturated fatty acids in milk fat primarily leads to which rheological change?
(A) Lower solid fat content at ambient temperature
(B) Elevated melting point and harder texture
(C) Increased spreadability of butter
(D) Enhanced susceptibility to autoxidation

2012

7. Which of the following is the correct pair of a milk fat fatty acid and its typical melting point?
(A) Butyric acid : 18.2 °C
(B) Oleic acid : 32.5 °C
(C) Stearic acid : 69.6 °C
(D) Linoleic acid : 14.1 °C

2019

8. In assessing the triglyceride structure of milk fat, stereospecific analysis reveals that butyric acid is predominantly esterified at which position on the glycerol backbone?
(A) sn-1 position
(B) sn-2 position
(C) sn-3 position
(D) Randomly distributed across all positions

2024

9. Match the MFGM components (List I) with their primary functional characteristics (List II).

List I: (MFGM components)

P. Xanthine oxidase
Q. Sphingomyelin
R. Mucin
S. Butyrophilin

List II: (Functional characteristics)

1. Glycoprotein providing steric repulsion
2. Major integral protein interacting with inner coat
3. Metalloenzyme generating reactive oxygen species
4. Polar lipid containing ceramide

(A) P-2, Q-4, R-1, S-3
(B) P-3, Q-1, R-4, S-2
(C) P-3, Q-4, R-1, S-2
(D) P-1, Q-2, R-3, S-4

2006

10. The relatively high proportion of short-chain fatty acids in milk fat can be inferred to primarily affect which physical property?

(A) Increase in the refractive index
(B) Broadening of the melting range
(C) Elevation of the smoke point
(D) Decrease in overall water solubility

2014

11. Which crystal polymorphic form of milk fat is the most thermodynamically stable and has the highest melting point?

(A) Alpha (α)
(B) Beta prime ($beta'$)
(C) Beta (β)
(D) Gamma (γ)

2013

12. Solid Fat Content (SFC) in dairy fats is most accurately and non-destructively measured using which analytical technique?

(A) Nuclear Magnetic Resonance (NMR)
(B) Differential Scanning Calorimetry (DSC)
(C) Gas Chromatography (GC)
(D) High-Performance Liquid Chromatography (HPLC)

2005

13. Which statement regarding milk fat crystallization is INCORRECT?

(A) Rapid cooling promotes the formation of unstable alpha crystals.
(B) Polymorphic transitions typically proceed from alpha to beta prime to beta forms.`
(C) Beta crystals exhibit a loosely packed, subcell hexagonal structure.
(D) Mixed triglyceride composition restricts pure beta crystal formation in milk fat.

2007

14. Given below are two statements: one is labeled as Assertion (A) and the other is labeled as Reason (R).

Assertion (A): The spreadability of butter is heavily dependent on the ratio of solid to liquid fat at storage temperatures.

Reason (R): Higher solid fat content reduces the continuous oil phase required for structural plasticity.

(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2006

15. Based on their melting behavior, milk fat triglycerides are generally classified into high, middle, and low melting fractions. Which fatty acid dominates the high melting fraction?

(A) Oleic acid
(B) Caproic acid
(C) Palmitic acid
(D) Linolenic acid

2023

16. Identify the correct combination of statements concerning milk fat rheology.

I. Penetrometry measures the hardness or yield stress of butter.
II. Isothermal crystallization only yields the beta polymorph.
III. The work of softening is determined using a cone penetrometer.
IV. The transition from beta prime to beta is an endothermic process.

Which of the following represents exactly two correct statements?

(A) II and IV
(B) III and IV
(C) I and III
(D) I and II

2017

17. Compared to cocoa butter, milk fat has a lower tendency to form pure beta crystals primarily due to:

(A) Significantly lower saturation levels in its fatty acids

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(B) Elevated concentrations of specific trans fatty acid isomers
(C) Much higher content of complex membrane phospholipids
(D) Greater triglyceride diversity and molecular asymmetry

2007
18. The rheological property known as "yield stress" in butter refers to:
(A) The minimum force required to initiate flow
(B) The dynamic viscosity of the completely melted fat phase
(C) The speed of polymorphic fat crystallization during cooling
(D) The physical resistance of the fat emulsion to phase inversion

2023
19. Match the analytical method (List I) with the parameter it measures in milk fat (List II).
List I: (Analytical method)
P. DSC
Q. Pulsed NMR
R. Cone Penetrometer
S. X-ray Diffraction
List II: (Parameter measured)
1. Crystal polymorphic forms
2. Solid Fat Content
3. Melting and crystallization enthalpies
4. Yield stress and hardness
(A) P-3, Q-2, R-4, S-1
(B) P-2, Q-3, R-1, S-4
(C) P-4, Q-1, R-3, S-2
(D) P-1, Q-4, R-2, S-3

2004
20. To improve the spreadability of butter made from hard winter milk fat, cream is subjected to which temperature crystallization program (Alnarp method) during aging?
(A) Constant holding at 4 °C until churning
(B) Rapid cooling to 6 °C, warming to 20 °C, then cooling to 12 °C
(C) Slow cooling to 20 °C, followed by rapid freezing to -5 °C
(D) Constant holding at 21 °C followed by direct churning at that temperature

2018
21. According to Stokes' law, the terminal velocity of fat globules during centrifugal separation is directly proportional to the:
(A) Viscosity of the continuous skim milk phase
(B) Viscosity of the milk fat phase
(C) Mathematical inverse of the density difference
(D) Square of the fat globule diameter

2021
22. Identify the correct combination of statements regarding cream standardization and neutralization.
I. Neutralization of sour cream is performed to prevent high fat loss in buttermilk during churning.
II. Sodium bicarbonate is a common neutralizer that releases carbon dioxide during the process.
III. Over-neutralization of cream can cause saponification, leading to a soapy flavor defect.
IV. Cream ripening is performed at high temperatures (> 45 °C) to maximize butyric acid production.
Which of the following represents exactly three correct statements?
(A) I, II and IV
(B) I, III and IV
(C) I, II and III
(D) II, III and IV

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2016
23. During cream ripening for cultured butter, the optimal production of diacetyl by Lactococcus lactis subsp. lactis biovar. diacetylactis occurs predominantly via the metabolism of:
(A) Lactose
(B) Casein
(C) Citrate
(D) Triglycerides

2005
24. Given below are two statements: one is labeled as Assertion (A) and the other is labeled as Reason (R).
Assertion (A): The efficiency of cream separation decreases as the temperature of milk is lowered below 35 °C.
Reason (R): Lower temperatures exponentially increase the viscosity of the continuous plasma phase, impeding globule mobility.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2010

25. The addition of calcium hydroxide (lime) during cream neutralization can cause an undesired effect. What is the primary cause-and-effect relationship?

(A) Casein precipitation by lime, leading to higher fat loss in buttermilk
(B) Rapid increase in pH by lime, instantly stopping all active bacterial metabolism
(C) Direct oxidation of unsaturated lipids, causing rapid onset of rancid off-flavors
(D) Chemical breakdown of lactose, causing excessive Maillard browning during pasteurization

2018

26. All of the following are physical changes that occur during the aging/ripening of cream EXCEPT:

(A) Progressive hydration and swelling of milk proteins
(B) Complete desorption of outer MFGM proteins
(C) Controlled crystallization of liquid core fat
(D) Structural weakening of the fat globule membrane

2003

27. Select the correct operational sequence for the standard preparation of cream for churning.

(A) Separation → Pasteurization → Neutralization → Ripening/Aging → Standardization
(B) Separation → Standardization → Neutralization → Pasteurization → Ripening/Aging
(C) Pasteurization → Separation → Ripening/Aging → Neutralization → Standardization
(D) Neutralization → Separation → Standardization → Ripening/Aging → Pasteurization

2005

28. In centrifugal separation terminology, the "skimming efficiency" is defined primarily by:

(A) The residual fat content in the skim milk
(B) The volume of cream produced per hour
(C) The speed of the centrifuge bowl
(D) The size of the largest fat globule retained

2003

29. Match the cream processing parameter (List I) with its primary technological purpose (List II).

List I: (Cream processing parameter)
P. Forewarming to 40 °C
Q. Addition of starter culture
R. Holding at 10 °C for 12 hours
S. Vacuum treatment

List II: (Technological purpose)
1. Removal of volatile off-flavors
2. Facilitation of beta prime crystal formation
3. Reduction of milk viscosity for separation
4. Development of aroma compounds

(A) P-3, Q-4, R-2, S-1
(B) P-2, Q-1, R-4, S-3
(C) P-1, Q-3, R-2, S-4
(D) P-3, Q-2, R-1, S-4

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2019

30. Which of the following conditions during cream aging and churning is most critical in minimizing fat loss in buttermilk?

(A) Churning cream with very low fat content (below 15%)
(B) Churning at a high temperature (above 20 °C)
(C) Having an adequate proportion of solid fat (typically 30-45%) in the cream
(D) Churning immediately after pasteurization without cooling

2002

31. Compared to the Fritz continuous butter making process, the traditional batch churning process typically requires:

(A) Higher churning speeds exceeding 3000 rpm
(B) Complete exclusion of air during churning
(C) Lower cream fat concentrations (around 30-35%)
(D) Higher pasteurization temperatures for the cream

2006

32. According to the phase inversion theory of churning, butter is formed when:

(A) A water-in-oil emulsion converts to an oil-in-water emulsion
(B) An oil-in-water emulsion converts to a water-in-oil emulsion
(C) Fat crystals dissolve entirely in the continuous serum phase
(D) The MFGM becomes fully polymerized

2010

33. Given below are two statements: one is labeled as Assertion (A) and the other is labeled as Reason (R).

Assertion (A): In continuous butter making, moisture control is often achieved by precisely injecting water into the working section.

Reason (R): Continuous churns operate at fixed

speeds and do not allow for the natural expulsion of buttermilk.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2024
34. Which of the following statements correctly describes the calculation for percent overrun in butter?
(A) $\left[\frac{\text{Weight of butter} - \text{Weight of fat}}{\text{Weight of fat}}\right] \times 100$
(B) $\left[\frac{\text{Weight of butter} - \text{Weight of butter milk}}{\text{Weight of fat}}\right] \times 100$
(C) $\left[\frac{\text{Volume of butter} - \text{Volume of cream}}{\text{Volume of cream}}\right] \times 100$
(D) $\left[\frac{\text{Weight of fat in cream} - \text{Weight of butter}}{\text{Weight of butter}}\right] \times 100$

2009
35. Identify the INCORRECT combination of statements regarding butter defects.
I. "Primrose" defect is a color variation caused by surface dehydration.
II. "Fishy" flavor is caused by the autoxidation of cholesterol.
III. "Mottled" appearance is strictly due to microbial contamination.
Which of the following represents exactly two incorrect statements?
(A) I and II
(B) I and III
(C) II and III

2003
36. To eliminate the occurrence of a "leaky" body defect in butter, a manufacturer should ensure:
(A) Thorough working to finely disperse moisture
(B) Significantly reduced working time within the churn
(C) Utilizing much higher wash water temperatures
(D) Complete removal of sodium chloride from the mix

2011
37. Arrange the fundamental stages of continuous butter making (Fritz process) in the correct operational sequence.
I. Working and texturizing
II. Separation of buttermilk
III. Churning cylinder (agitation)
IV. Moisture dosing and final mixing
(A) III → I → II → IV
(B) III → II → I → IV
(C) II → III → IV → I
(D) II → I → III → IV

2021
38. The incorporation of excessive air during the churning process primarily leads to which effect?
(A) Significantly increased yield of buttermilk
(B) Rapid onset of oxidative rancidity
(C) Enhanced retention of volatile diacetyl
(D) Complete prevention of enzymatic lipolysis

2014
39. Match the theoretical concept of churning (List I) with its key proposing scientist(s) (List II).
List I: (Theoretical concept of churning)
P. Phase Inversion Theory
Q. Foam Theory
R. Fat Globule Agglomeration
S. Surface Adsorption
List II: (Proposing scientist)
1. Rahn
2. Fischer and Hooker
3. Van Dam
4. King
(A) P-1, Q-2, R-3, S-4
(B) P-2, Q-1, R-4, S-3
(C) P-2, Q-1, R-3, S-4
(D) P-3, Q-4, R-1, S-2

2014
40. From the presence of a "cheesy" flavor defect in butter, one can most likely infer the excessive activity of which class of enzymes during cream storage?
(A) Lipases
(B) Oxidoreductases
(C) Phosphatases
(D) Proteases

2009
41. In the pre-stratification method of ghee making, the bottom layer formed after heating primarily consists of:
(A) Buttermilk serum (moisture)
(B) Floating protein scum
(C) Pure ghee fat
(D) Volatile ketones

2007
42. When applying the creamery butter method for ghee production, the melting of butter is typically controlled to minimize which outcome?

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(A) Loss of short-chain fatty acids through volatilization
(B) Browning of milk solids-not-fat
(C) Formation of free radicals
(D) Excessive moisture retention

2007

43. Given below are two statements: one is labeled as Assertion (A) and the other is labeled as Reason (R).
Assertion (A): Ghee produced by the desi method typically exhibits a higher degree of oxidative stability than ghee produced by the direct cream heating method.
Reason (R): The high heat treatment in the presence of cultured solids during desi ghee production generates antioxidant sulfhydryl compounds.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2025

44. All of the following compounds contribute significantly to the characteristic flavor of ghee EXCEPT:
(A) Indole
(B) Carbonyls
(C) Lactones
(D) Free fatty acids

2001

45. Identify the INCORRECT combination of statements regarding lipid autoxidation in ghee.
I. Autoxidation is a free-radical, chain reaction process.
II. Hydroperoxides are primary unstable oxidation products.
III. Copper and iron act as pro-oxidants accelerating the initiation phase.
IV. Antioxidants function by donating hydrogen atoms to terminate radical chains.
Which of the following represents exactly two incorrect statements?
(A) I and II
(B) III and IV
(C) I and III
(D) II and IV

2022

46. The structural matrix of ghee residue is primarily defined by the presence of:
(A) Crystallized high-melting-point triglycerides
(B) Intact casein micelle structures suspended in water
(C) Unesterified free fatty acid fractions
(D) Denatured proteins, lactose, and phospholipids

2003

47. Which pair correctly identifies a ghee grading standard parameter and its FSSAI permissible limit?
(A) Moisture content: Maximum limit of 1.0%
(B) Free Fatty Acids (as oleic): Maximum of 3.0%
(C) RM value: Varies by state (minimum 21-28)
(D) Baudouin test reaction: Must be strongly positive

2005

48. Heating ghee to temperatures exceeding 120 °C primarily causes:
(A) The destruction of natural lactones, reducing flavor intensity
(B) Intense Maillard reactions yielding a burnt flavor
(C) The complete crystallization of the fat phase upon cooling
(D) The rapid hydration of complex polar membrane phospholipids

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2009

49. Match the ghee processing method (List I) with its distinctive characteristic (List II).
List I: (Ghee processing method)
P. Desi method
Q. Direct cream method
R. Creamery butter method
S. Pre-stratification method
List II: (Distinctive characteristic)
1. Highest energy efficiency due to moisture drainage
2. Traditional lactic fermentation flavor profile
3. High serum solids leading to darker color
4. Uses standard unsalted butter as raw material
(A) P-2, Q-3, R-4, S-1
(B) P-1, Q-4, R-2, S-3
(C) P-3, Q-1, R-4, S-2
(D) P-2, Q-4, R-1, S-3

2019

50. What is a primary disadvantage of the direct cream heating method for ghee production compared to the pre-stratification method?
(A) Higher thermal energy required to evaporate

moisture
(B) Complete and irreversible loss of all essential fatty acids
(C) Absolute inability to develop any desirable granular texture
(D) Excessive and rapid production of free fatty acids in the fat

2024

51. Dry fractionation of milk fat relies fundamentally on which physicochemical principle?
(A) Differential solubility in volatile organic solvents
(B) Density differences between specific triglyceride classes
(C) Crystallization based on melting points
(D) Volatility differences under high vacuum conditions

2006

52. Which statement regarding solvent fractionation of milk fat is INCORRECT?
(A) It is the most widely adopted method for edible dairy products globally.
(B) Acetone and hexane are commonly used solvents.
(C) It produces sharper separations than dry fractionation.
(D) It requires significant downstream processing to remove solvent residues.

2022

53. In aqueous (detergent) fractionation of milk fat, the separation of liquid and solid fractions is primarily facilitated by:
(A) Fractional distillation columns operating at high temperatures
(B) High-pressure filtration through specialized membranes
(C) Controlled gravity settling over a period of 48 hours
(D) Centrifugal separation using a surfactant

2024

54. The term "olein" in the context of milk fat fractionation is defined as:
(A) The solid fraction rich in highly saturated triglycerides
(B) The liquid phase enriched in unsaturated lipids
(C) The solid crystalline residue left at a given temperature
(D) The lipid fraction exclusively composed of polar membrane lipids

2006

55. Identify the correct combination of statements regarding tailored milk fat fractions.
I. High-melting fractions are used to improve the flakiness of pastries.
II. Low-melting fractions are utilized to increase the spreadability of cold butter.
III. Middle-melting fractions are strictly avoided in chocolate formulations.
Which of the following represents exactly two correct statements?
(A) II and III
(B) I and II
(C) I and III
(D) None of the above

2017

56. Identify the combination of statements regarding milk fat fractionation.
I. Dry fractionation does not involve the use of any organic solvents.
II. Solvent fractionation has a lower separation efficiency than dry fractionation.
III. The stearin fraction contains a higher proportion of unsaturated fatty acids than the olein fraction.
IV. Detergent fractionation uses high temperatures to hydrolyze milk fat.
V. Super-olein remains liquid at lower temperatures than standard olein.
Which of the following represents exactly three INCORRECT statements?
(A) I, II and III
(B) II, III and IV
(C) III, IV and V
(D) I, IV and V

2025

57. The primary cause of lower fractionation efficiency in dry fractionation compared to solvent fractionation is:
(A) Entrainment of olein within stearin crystals
(B) Extremely high latent heat of triglycerides crystallization
(C) Rapid and uncontrolled polymorphic transition of fat crystals
(D) Thermal destruction of short-chain fatty acids during heating

2016

58. An application requiring a milk fat component that remains clear and liquid at refrigeration temperatures would utilize which specific fraction?
(A) Hard stearin

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(B) Super-olein
(C) Middle-melting fraction
(D) Anhydrous milk fat

2016

59. Which of the following is NOT a characteristic typically associated with the stearin fraction of milk fat?
(A) Elevated solid fat content at 20 °C
(B) Increased solubility in cold ethanol
(C) Lower concentration of flavor compounds like lactones
(D) Higher melting point than intact milk fat

2011

60. What is the primary advantage of dry fractionation over solvent and aqueous fractionation methods?
(A) No chemical residues, preserving a clean label
(B) Achieving complete one hundred percent purity of triglyceride classes
(C) Continuous operation at ambient room temperature without any cooling
(D) Complete prevention of any crystal polymorphic changes during storage

2004

61. In the manufacturing of margarine, the aqueous phase is typically dispersed into the continuous fat phase using which piece of equipment?
(A) High-pressure industrial homogenizer
(B) High-capacity centrifugal clarifier
(C) Scraped-surface heat exchanger
(D) Rotary spray dryer atomization disk

2018

62. Which class of fat replacer acts primarily by binding water to form a gel matrix that mimics the texture and mouthfeel of fat?
(A) Lipid-based (e.g., Olestra)
(B) Protein-based (e.g., Simplesse)
(C) Emulsifier-based (e.g., Mono/diglycerides)
(D) Carbohydrate-based (e.g., Maltodextrin)

2009

63. Compared to traditional butter, low-fat spreads (containing ~40% fat) face a major technological challenge regarding:
(A) Controlling rapid lipid autoxidation during long-term storage
(B) Achieving complete and adequate phase inversion during processing
(C) Microbiological decay due to higher moisture
(D) Preventing excessive hardness at standard refrigeration temperatures

2006

64. A technologist formulating a low-fat dairy spread notices rapid emulsion breakdown (syneresis) during storage. Which intervention is most appropriate?
(A) Significantly increasing the mechanical churning speed
(B) Incorporating a hydrocolloid stabilizer
(C) Raising the product storage temperature to exactly 15 °C
(D) Decreasing the overall concentration of active emulsifiers

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2009

65. Identify the INCORRECT pair regarding fat replacers and their structural basis.
(A) Simplesse : Microparticulated whey protein
(B) Oatrim : Hydrolyzed oat flour (beta-glucan)
(C) Polydextrose : Synthetic polymer of glucose
(D) Olestra : Cross-linked starch derivative

2022

66. Identify the correct combination of statements concerning emulsion stability in spreads.
I. Emulsions are thermodynamically unstable systems.
II. Monoglycerides act to lower the interfacial tension between water and oil.
III. Coalescence is completely prevented by increasing the fat globule size.
IV. High-shear mixing during cooling helps generate small, stable water droplets.
Which of the following represents exactly three correct statements?
(A) I, II and III
(B) II, III and IV
(C) I, II and IV
(D) I, III and IV

2019

67. Select the correct sequence of fundamental unit operations in standard margarine production.
(A) Emulsion preparation → Pre-crystallization → Votator processing → Resting/Pin-working
(B) Votator processing → Emulsion preparation → Packaging → Pin-working
(C) Emulsion preparation → Votator processing → Resting/Pin-working → Packaging
(D) Resting/Pin-working → Emulsion preparation → Votator processing → Packaging

2003

68. If a lipid-based fat replacer provides 0 kcal/g, one can logically infer that it is:

(A) Resistant to pancreatic lipases
(B) Characterized as being highly water soluble
(C) Completely volatile at normal human body temperature
(D) Composed entirely of volatile short-chain fatty acids

2022

2018

69. The deliberate induction of beta prime (beta′) crystals over beta (β) crystals in margarine production causes which desirable effect?
(A) Increased product graininess and a sandy physical texture
(B) Lower melting point and enhanced separation of the liquid oil
(C) Complete and absolute resistance to any lipid auto-oxidation
(D) A smooth network that immobilizes liquid oil

2006

70. "Microparticulation" is best defined as a process that:
(A) Enzymatically hydrolyzes bulk triglycerides into fine micro-emulsions
(B) Shears heated proteins into spherical, fat-like particles
(C) Chemically cross-links carbohydrates to form indigestible dietary fibers
(D) Encapsulates fat droplets within a rigid, insoluble calcium alginate matrix

2009

71. Em emulsifier with a Hydrophilic-Lipophilic Balance (HLB) value of 4 is chemically classified as lipophilic and is most typically used to promote which type of emulsion?
(A) Stable oil-in-water (O/W) emulsion
(B) Stable gas-in-water foam
(C) Water-in-oil (W/O) emulsion
(D) Micro-emulsion of starch in water

2024

72. Which milk constituent contributes most significantly to the structural air cell stability and overrun capacity in ice cream?
(A) Lactose sugar
(B) Milk fat lipids
(C) Calcium phosphate
(D) Milk proteins

2025

73. Stabilizers used in frozen dairy formulations are generally classified chemically as:
(A) Polysaccharides
(B) Polar membrane phospholipids
(C) Hydrophobic synthetic polypeptides
(D) High-melting-point triglycerides

2007

74. According to FSSAI regulatory standards for standard ice cream, which of the following requirements is strictly enforced?
(A) Maintaining a minimum fat content of exactly 15%
(B) Minimum weight per unit volume
(C) Enforcing a maximum limit on overrun of 50%
(D) Complete prohibition of any artificial coloring agents

2016

75. To avoid the "sandiness" defect in ice cream, a manufacturer should eliminate which of the following practices?
(A) Utilizing standard sodium alginate as the primary stabilizer
(B) Formulating with excess lactose from whey powder
(C) Homogenizing the mix at excessively high mechanical pressures
(D) Aging the standardized mix at 4 °C for exactly 12 hours

2001

76. Identify the correct combination of statements concerning stabilizers and emulsifiers in ice cream.
I. Emulsifiers displace proteins from the fat globule surface during aging.
II. Stabilizers increase the viscosity of the unfrozen aqueous phase.
III. Tween 80 has a high HLB value and promotes partial fat coalescence.
IV. Locust bean gum functions primarily by cross-linking caseins.
V. Gelatin requires cold-swelling and cannot be heated.
Which of the following represents exactly three correct statements?
(A) I, II and III
(B) II, III and V
(C) I, III and IV
(D) III, IV and V

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2023

77. Arrange the following emulsifiers/stabilizers in increasing order of their typical HLB values.
I. Polysorbate 80
II. Mono- and diglycerides
III. Sodium stearoyl lactylate
IV. Sorbitan monostearate
(A) II → IV → III → I
(B) I → III → IV → II
(C) IV → II → I → III
(D) II → I → IV → III

2001

78. Which statement correctly identifies the functional role of polysorbates in ice cream?
(A) They strongly bind free water, preventing dynamic ice crystal growth
(B) They significantly depress the initial freezing point of the mix
(C) They act as primary nutritive sweetening and bulking agents
(D) They promote partial coalescence of fat globules

2013

79. The Hydrophilic-Lipophilic Balance (HLB) scale is mathematically defined to measure:
(A) The physical ratio of moisture to fat in a standard emulsion
(B) The exact pH value at which a specific ionic emulsifier precipitates
(C) The affinity of a surfactant for oil versus water
(D) The average molecular weight of the synthetic surfactant polymer

2005

80. The addition of excessive amounts of stabilizer to an ice cream mix typically results in which effect?
(A) Extremely fast melt-down rate
(B) A heavy, gummy, or chewy body defect
(C) High susceptibility to heat shock
(D) Increased formation of large ice crystals

2024

81. The standard pasteurization requirement for an ice cream mix is generally higher than that for fluid milk primarily because:
(A) Ice cream mixes lack native antimicrobial enzymes like lactoferrin and lysozyme
(B) The physical mixing process introduces highly heat-resistant environmental spores
(C) Pathogens multiply much more rapidly at freezing and refrigeration temperatures
(D) Viscosity and high solids protect microorganisms from heat

2009

82. Which statement regarding ice cream mix homogenization is INCORRECT?
(A) It significantly decreases the viscosity of the mix.
(B) It reduces the size of fat globules to approximately 0.5 - 2.0 microns.
(C) It enhances the whipping quality of the mix.
(D) It requires two stages for optimal disruption and prevention of clustering.

2012

83. If an ice cream mix exhibits a tendency to churn out (form visible butter granules) during dynamic freezing, the most logical formulation adjustment is to:
(A) Increase the aging time from 4 to 24 hours
(B) Decrease the homogenization pressure
(C) Reduce the amount of added emulsifier
(D) Increase the milk fat content

2013

84. What is the primary cause of protein desorption from the fat globule membrane during the aging of ice cream mix?
(A) Competitive adsorption and displacement by added emulsifiers
(B) Rapid degradation of casein micelles by lipases
(C) Crystallization of the fat, which alters the physical state of the membrane
(D) Drop in mix pH to below 4.6

NODIA

2009

85. Which parameter optimally describes the aging condition for a standard commercial ice cream mix?
(A) 0 to 4 °C for 4 to 24 hours
(B) -5 to 0 °C for 1 to 2 hours
(C) 10 to 15 °C for 48 hours
(D) 20 to 25 °C for 30 minutes

2004

86. Aging of ice cream mix induces all of the following physicochemical changes EXCEPT:
(A) Hydration of stabilizers
(B) Substantial Maillard browning
(C) Crystallization of liquid fat inside the globules
(D) Slight increase in mix viscosity

2015

87. Compared to a mix homogenized at low pressure, a mix homogenized at optimal high pressure (e.g., 2000 psi) will exhibit:
(A) Lower surface area of fat
(B) Slower freezing rates
(C) A smoother texture and better emulsion stability
(D) Higher susceptibility to churning during freezing

2025

88. The term "partial coalescence" in ice cream processing refers specifically to:
(A) The complete merging of two fat globules into a single spherical fat droplet
(B) The physical binding of free water molecules by complex hydrocolloids
(C) The rapid precipitation of insoluble lactose crystals during active freezing
(D) Fat globule agglomeration via penetrating crystals

2007

89. Which pair correctly associates a mix processing step with its primary physical outcome?
(A) Aging: Crystallization and protein desorption
(B) Pasteurization: Significant fat globule size reduction
(C) Homogenization: Complete hydration of all hydrocolloids
(D) Freezing: Absolute destruction of all pathogenic bacteria

2005

90. A major disadvantage of bypassing the aging process in ice cream mix preparation is:
(A) A highly dramatic increase in the overall processing time
(B) Reduced overrun and weak body structure
(C) Excessive and uncontrolled fat coalescence during pasteurization
(D) Immediate and complete precipitation of dissolved sucrose

2010

91. The initial freezing point of a typical standard ice cream mix is approximately:
(A) 0 °C
(B) -2.5 °C
(C) -5.0 °C
(D) -18.0 °C

2003

92. Regarding the thermodynamics of freezing ice cream, which statement is INCORRECT?
(A) The freezing point of the remaining solution rises during freezing
(B) As liquid water freezes into ice, the solute concentration in the unfrozen phase increases
(C) Latent heat of fusion from water must be continually removed by the system refrigerant
(D) Complete and absolute freezing of all water in ice cream rarely occurs even at -30 °C

2013

93. Given below are two statements: one is labeled as Assertion (A) and the other is labeled as Reason (R).
Assertion (A): Rapid continuous freezing in a scraped-surface heat exchanger produces a smoother ice cream than slow static freezing.
Reason (R): Rapid freezing rates promote high nucleation rates, resulting in a large number of very small ice crystals.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2019

94. The primary mechanical function of the dasher and scraper blades inside the dynamic freezer is to:
(A) Prevent any fat globule coalescence or churning from occurring
(B) Homogenize the various mix components one final time before exit
(C) Inject pressurized liquid nitrogen gas directly into the product mix
(D) Scrape ice from walls to enhance heat transfer

2023

95. The volumetric overrun formula based on weight is:
(A) $\left[\frac{\text{Weight of ice cream} - \text{Weight of mix}}{\text{Weight of mix}}\right] \times 100$
(B) $\left[\frac{\text{Volume of mix} - \text{Volume of ice cream}}{\text{Volume of ice cream}}\right] \times 100$
(C) $\left[\frac{\text{Weight of mix} - \text{Weight of ice cream}}{\text{Weight of ice cream}}\right] \times 100$
(D) $\left[\frac{\text{Weight of mix} + \text{Weight of ice cream}}{\text{Weight of ice cream}}\right] \times 100$

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2003

96. The size of ice crystals in hardened ice cream is influenced by all of the following factors EXCEPT:
(A) The average residence time of the mix inside the dynamic freezer
(B) Atmospheric pressure outside the plant
(C) The speed of static hardening within the specialized cold tunnel
(D) Continuous temperature fluctuations during storage and transport

2016

97. Compared to dynamic freezing, the static hardening process focuses primarily on:
(A) Incorporating the maximum possible amount of air to achieve overrun
(B) Rapidly reducing the average physical size of existing ice crystals
(C) Promoting controlled, partial coalescence of the milk fat globules
(D) Freezing remaining free water without agitation

2006

98. "Heat shock" in frozen dairy desserts refers to:
(A) Temperature cycles causing ice crystal accretion
(B) The high-temperature pasteurization of the mix prior to freezing
(C) The rapid mechanical supercooling of the mix in a continuous freezer
(D) The initial thermal resistance exhibited by bacterial endospores

2021

99. Match the freezing phase (List I) with its corresponding typical temperature or physical state (List II).
List I: (Freezing phase)
P. Mix inlet temperature
Q. Dynamic freezing draw temperature
R. Hardening room temperature
S. Free water frozen at draw
List II: (Typical temperature or physical state)
1. -30 °C to -40 °C
2. Approx. 4 °C
3. -5 °C to -7 °C
4. Approx. 50%
(A) P-2, Q-3, R-1, S-4
(B) P-3, Q-2, R-4, S-1
(C) P-1, Q-4, R-3, S-2
(D) P-2, Q-1, R-3, S-4

2005

100. A major advantage of achieving a highly stiff extrusion (low draw temperature) from a continuous freezer is:
(A) Smaller ice crystal size and better shape retention
(B) Significantly reduced requirement for hydrocolloid stabilizers
(C) Decreased product viscosity during the automated packaging step
(D) Lower electrical power consumption by the internal dasher motor

2006

101. Soft-serve ice cream differs fundamentally from standard hard ice cream in that soft-serve:
(A) Contains absolutely no dairy fat or fat substitutes
(B) Utilizes strictly high-intensity artificial sweeteners
(C) Employs a zero percent overrun formulation throughout
(D) Served directly without hardening at -5 °C

2004

102. When formulating a diabetic ice cream, which of the following approaches is INCORRECT?
(A) Replacing sucrose with a non-glycemic sweetener like sucralose
(B) Removing all stabilizers to lower the glycemic index
(C) Using bulking agents like polydextrose to replace the dry mass of sugar
(D) Utilizing sugar alcohols (polyols) for freezing point depression

2008

103. To manufacture a low-fat ice cream without sacrificing mouthfeel, a technologist should heavily rely on:
(A) Increasing the sucrose sweetening concentration by exactly 10%
(B) Eliminating all active emulsifiers from the formulation
(C) Adding microparticulated proteins and hydrocolloids
(D) Raising the initial mix freezing point temperature significantly

2021

104. Incorporating highly acidic fruit pulps directly into an unbuffered ice cream mix prior to freezing typically causes:
(A) Rapid and uncontrolled increase in overrun
(B) Complete biochemical destruction of lactose
(C) Instantaneous fat crystallization inside the

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mix
(D) Protein curdling

2010
105. Select the correct sequence for safely incorporating fruit pieces into a commercial ice cream continuous production line.
(A) Mix formulation → Fruit addition → Pasteurization → Dynamic Freezing → Hardening
(B) Mix formulation → Pasteurization → Dynamic Freezing → Fruit addition via fruit feeder → Hardening
(C) Fruit addition → Mix formulation → Dynamic Freezing → Pasteurization → Hardening
(D) Pasteurization → Fruit addition → Mix formulation → Hardening → Dynamic Freezing

2005
106. Dietetic ice creams targeting calorie reduction typically utilize all of the following modifications EXCEPT:
(A) Substitution of milk fat with fat replacers
(B) Replacement of all water with concentrated liquid milk fat
(C) Replacement of sucrose with high-intensity sweeteners and bulking agents
(D) Increase in overrun to reduce density and weight per serving

2015
107. Compared to sucrose, the use of Sorbitol in diabetic frozen desserts exhibits:
(A) A significantly higher blood glycemic index response
(B) Greater freezing point depression per gram
(C) Absolute zero physical bulking capacity in the mix
(D) Complete and irreversible insolubility in cold mixes

2001
108. A "mellorine" type frozen dessert is legally defined in many jurisdictions as one where:
(A) Replacement of milk fat with vegetable fat
(B) Complete replacement of all milk solids-not-fat by soy proteins
(C) Formulating the mix so that overrun exceeds 150%
(D) Designing the product to contain active probiotic cultures

2002
109. Which pair accurately matches a specialty frozen dessert with its key characteristic?
(A) Sorbet: High dairy fat content above fifteen percent
(B) Sherbet: Complete zero percent milk solids formulation
(C) Gelato: Low overrun and dense texture
(D) Frozen yogurt: Extruded and served at exactly zero degrees

2013
110. The major technological disadvantage of using excessive fruit syrups in specialty ice creams is:
(A) Significantly elevated freezing point causing a rock-hard texture
(B) Complete prevention of heat transfer and pasteurization efficacy
(C) Total elimination of any natural coloring pigments in the mix
(D) Drastic freezing point lowering, causing softness

NODIA

2024
111. Arrange the traditional steps in the manufacture of authentic Kulfi.
I. Addition of sugar and nuts
II. Slow concentration of milk in an open pan
III. Filling into metallic cones (molds)
IV. Static freezing in an ice-salt mixture
(A) II → I → III → IV
(B) I → II → IV → III
(C) II → III → I → IV
(D) III → I → II → IV

2009
112. Which statement regarding traditional Kulfi is INCORRECT?
(A) It has a higher concentration of milk solids than standard ice cream mix.
(B) It relies on continuous agitation during freezing to achieve high overrun.
(C) Its authentic flavor is heavily influenced by intense heating and Maillard reactions.
(D) It typically exhibits a dense, icy texture due to static freezing.

2017
113. To mimic the traditional caramelized flavor of Kulfi in a modern continuous production line, a technologist might:
(A) Add rennet enzymes directly to the pasteurized mix
(B) Freeze the mix at extremely slow mechanical shear rates
(C) Complete removal of all hydrocolloid

stabilizers
(D) Incorporate pre-caramelized condensed milk

2025
114. The distinct sandy or grainy texture often appreciated in traditional Malai-ka-baraf is primarily attributed to:
(A) Lactose and ice crystallization from unagitated freezing
(B) Deliberate additions of food-grade artificial sand particles
(C) Complete biochemical absence of lactose sugar in the formulation
(D) Extensive and high-pressure homogenization of fat globules

2009
115. According to typical compositional profiles, authentic Kulfi mix before freezing contains approximately:
(A) 5% Total Solids
(B) 10-12% Total Solids
(C) 35-40% Total Solids
(D) 70-75% Total Solids

2018
116. The traditional manufacture of Kulfi typically does NOT utilize:
(A) Evaporative concentration
(B) Earthen or metallic molds
(C) Scraped-surface heat exchangers
(D) Added sugar

2006
117. Compared to standard western ice cream, Kulfi is characterized by:
(A) Zero overrun and higher density
(B) Higher overrun and lighter body
(C) Lower milk solids and higher water content
(D) Lower melting resistance

2019
118. "Malai", a key component in indigenous Indian frozen desserts, refers to:
(A) The skim milk portion after centrifugation
(B) The whey separated from paneer
(C) The caramelized sugar crust
(D) The clotted cream layer formed on the surface of slowly heated milk

2003
119. Which of the following pairs correctly associates a traditional product with its primary freezing medium in historical contexts?
(A) Kulfi : Liquid Nitrogen
(B) Malai-ka-baraf : Brine or ice-salt mixture
(C) Gelato : Open pan cooling
(D) Sherbet : Vacuum cooling

2007
120. A major commercial disadvantage of the traditional Kulfi manufacturing process (open pan evaporation) is:
(A) Excessive incorporation of air leading to volume loss
(B) Inability to add dry fruits
(C) High variability in product quality and poor energy efficiency
(D) Total destruction of milk fat

2021
121. Low-Temperature Extrusion (LTE) technology allows ice cream to be drawn from the freezer at temperatures as low as:
(A) -2 °C to -4 °C
(B) -5 °C to -8 °C
(C) -12 °C to -15 °C
(D) -25 °C to -30 °C

2022
122. Which of the following is NOT a benefit of Low-Temperature Extrusion (LTE) of ice cream?
(A) Complete elimination of the subsequent static hardening step
(B) Significant reduction in the average size of ice crystals
(C) Enhanced creamy mouthfeel due to smaller fat agglomerates
(D) Highly increased structural resistance to melting at room temperature

2002
123. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): The survival of probiotic bacteria in frozen dairy desserts is often compromised during long-term storage.
Reason (R): Mechanical stress during freezing and osmotic stress from high sugar concentrations cause cellular injury and death.
(A) Both (A) and (R) are true and (R) is the correct explanation of (A).
(B) Both (A) and (R) are true but (R) is not the correct explanation of (A).
(C) (A) is true but (R) is false.
(D) (A) is false but (R) is true.

2004
124. Cryogenic freezing using liquid nitrogen primarily causes which physical phenomenon in ice cream production?

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(A) Complete chemical denaturation and destruction of native milk proteins
(B) Ultra-rapid freezing and formation of microscopic ice crystals
(C) Uncontrolled expansion of air cells leading to extremely high overrun
(D) Spontaneous phase inversion from oil-in-water to water-in-oil emulsion

2023

125. When incorporating functional ingredients like omega-3 fatty acids into ice cream, the primary technological hurdle is:
(A) Preventing oxidative rancidity and off-flavors
(B) Enhancing the intense Maillard browning
(C) Increasing the freezing point
(D) Ensuring the complete crystallization of lactose

2023

126. Recent advances in structured ice cream include the use of cryoprotectants to minimize ice crystal growth. All of the following function as cryoprotectants EXCEPT:
(A) Trehalose
(B) Antifreeze proteins (e.g., from deep-sea fish)
(C) Sodium chloride (in high concentrations)
(D) Polydextrose

2017

127. Compared to conventional continuous freezers, single-screw low-temperature extruders operate with:
(A) Lower torque requirements and reduced mechanical stress
(B) Significantly higher draw temperatures at the exit
(C) Strictly controlled and complete vacuum conditions
(D) Much higher shear rates and longer residence times

2012

128. "Antifreeze proteins" (AFPs) used in advanced frozen dessert formulations function primarily by:
(A) Depressing the freezing point of the mix to extremely low temperatures
(B) Replacing the milk fat globule membrane completely in the matrix
(C) Adsoring directly to ice crystal surfaces to inhibit further growth
(D) Binding strictly to lactose molecules to prevent grit formation

NODIA

2012

129. Match the advanced freezing technology listed in List I with its defining feature listed in List II.
List I: (Technology)
P. Liquid Nitrogen freezing
Q. High-pressure freezing
R. Low-Temperature Extrusion
S. Ultrasound-assisted freezing
List II: (Feature)
1. Induces micro-cavitation to promote ice nucleation
2. Alters thermodynamic phase diagrams to freeze at sub-zero temperatures without ice formation
3. Utilizes immense shear at highly viscous states (-12 °C)
4. Relies on vaporization at -196 °C for instant crust freezing
(A) P-2, Q-3, R-1, S-4
(B) P-4, Q-2, R-3, S-1
(C) P-3, Q-1, R-4, S-2
(D) P-1, Q-4, R-2, S-3

2015

130. A major disadvantage of utilizing encapsulated probiotics in ice cream, despite better survival, is:
(A) Drastic reduction in the final overrun of the ice cream
(B) Uncontrolled, rapid melting of the finished product
(C) Almost complete inhibition of the perceived sweetness
(D) Negative sensory impacts like a gritty or sandy texture

2012

131. The Alcohol (Ethanol) test is a rapid platform test primarily used to assess which milk quality parameter?
(A) Heat stability and protein integrity
(B) Total percentage of milk fat
(C) Cumulative microbiological count
(D) Adulteration of milk with water

2016

132. Regarding raw milk suitability for concentration and drying, which statement is INCORRECT?
(A) Mastitic milk often exhibits reduced heat stability.
(B) A positive clot-on-boiling (COB) test indicates unsuitability for thermal processing.
(C) Milk with high titratable acidity is preferred for evaporation.

(D) High spore counts strictly limit the shelf life of the resulting powder.

2006

133. If raw milk shows a positive test for the presence of neutralizers, it indicates:
(A) The addition of alkali to mask developed acidity
(B) The milk possesses exceptional native keeping quality
(C) The sample is entirely free from pathogenic bacteria
(D) The average somatic cell count is exceptionally low

2007

134. An elevated somatic cell count in raw milk primarily causes which issue in dried milk products?
(A) Significant enhancement of the powder solubility index
(B) Spontaneous instantization and agglomeration of the powder
(C) Complete physical resistance to subsequent Maillard browning
(D) Susceptibility to lipolysis and proteolysis, yielding off-flavors

2022

135. What is the correct sequence of routine platform tests performed on incoming raw milk tankers?
(A) Alcohol test → Titratable Acidity → Temperature check → Organoleptic evaluation
(B) Temperature check → Organoleptic evaluation → Alcohol test → Titratable Acidity
(C) Titratable Acidity → Temperature check → Alcohol test → Organoleptic evaluation
(D) Organoleptic evaluation → Alcohol test → Titratable Acidity → Temperature check

2003

136. All of the following tests evaluate the hygienic quality of raw milk EXCEPT:
(A) Methylene Blue Reduction Test (MBRT)
(B) Resazurin test
(C) Gerber test
(D) Standard Plate Count (SPC)

2017

137. Compared to fluid pasteurized milk, the raw milk selected for UHT concentrated milk processing requires:
(A) Strict and complete absence of native enzymes in the raw supply
(B) A significantly lower initial fat content compared to standard milk
(C) Consistently higher levels of dissolved oxygen in the bulk storage
(D) Higher thermal stability to withstand sterilization without coagulation

2004

138. The "Clot-on-Boiling" (COB) test is a simple visual assay determining:
(A) Protein coagulation upon heating, indicating high acidity or poor salt balance
(B) The illegal presence of added starch or similar thickening agents
(C) The exact percentage of native whey proteins remaining un-denatured
(D) The structural efficiency of the mechanical homogenization process

2004

139. Which of the following pairs correctly associates the platform test with its specific target?
(A) MBRT : High-throughput determination of exact somatic cell count
(B) Lactometer reading : Specific gravity (water adulteration)
(C) Alcohol test : Precise and rapid pH value measurement of raw milk
(D) Gerber test : Rapid quantification of lactose concentration in milk

2011

140. The primary advantage of the Resazurin test over the MBRT is:
(A) It requires an incubation period of exactly 24 hours to complete
(B) It provides a quicker, multi-stage colorimetric quality assessment
(C) It actively destroys all pathogenic micro-organisms during testing
(D) It simultaneously measures fat content along with microbial load

2005

141. Arrange the following components of a multiple-effect falling film evaporator in the correct sequence according to the direction of product flow:
I. Calandria (heating tubes)
II. Pre-heaters
III. Vapor separator
IV. Condenser
(A) II → I → III → IV
(B) I → II → IV → III
(C) II → III → I → IV

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(D) III → I → II → IV

2006
142. Regarding Mechanical Vapor Recompression (MVR), which statement is INCORRECT?
(A) It relies on a mechanical compressor to increase pressure and temperature of vapor
(B) It eliminates the need for any steam supply once the process is running steadily
(C) It consumes higher amounts of steam than a standard single-effect system
(D) It is typically driven by an electric motor or a steam-driven turbine system

2025
143. In a falling film evaporator, poor distribution of milk at the top of the calandria tubes will most likely result in:
(A) Significantly enhanced and uniform evaporation rates
(B) Immediate freezing of the milk inside the calandria
(C) Spontaneous mechanical homogenization of fat globules
(D) Dry spots, severe fouling, and reduced heat transfer

2009
144. Utilizing multiple effects in vacuum evaporation directly leads to:
(A) Increased cumulative steam consumption across the multiple stages
(B) Significantly higher boiling temperatures in the final thermal effect
(C) Re-use of latent heat to increase thermal efficiency (steam economy)
(D) Total chemical destruction of lactose and other milk sugars

2008
145. Thermal Vapor Recompression (TVR) operates by:
(A) Mechanically compressing process vapor using a high-speed centrifugal turbo-fan
(B) Entraining and compressing low-pressure vapor using a high-pressure steam jet
(C) Passing volatile vapor through a specialized scraped-surface heat exchanger
(D) Freezing the vapor under high vacuum conditions to recover the latent heat

2024
146. Vacuum evaporation of milk aims to achieve all of the following EXCEPT:
(A) Reduction in mass and volume for storage/ transport
(B) Pre-concentration prior to spray drying
(C) Lowering the boiling point to minimize thermal damage
(D) Complete sterilization of the milk

2004
147. Compared to rising film evaporators, falling film evaporators offer the advantage of:
(A) Operation at smaller temperature differences (ΔT)
(B) Significantly higher product residence times in tubes
(C) Being entirely unaffected by product viscosity changes
(D) Completely eliminating the need for a vacuum system

2010
148. "Steam economy" in the context of milk evaporation is defined as:
(A) The total operating cost of steam utilized per processing hour
(B) The mass ratio of finished product output to total steam input
(C) Kilograms of water evaporated per kilogram of steam consumed
(D) The cumulative percentage of volatile vapor condensed in system

NODIA

2005
149. Which of the following pairs correctly matches the thermodynamic component with its primary function in an evaporator?
(A) Calandria : Transfers heat from steam to milk across tubes
(B) Thermocompressor : Condenses final process vapors into liquid water
(C) Vacuum pump : Adds thermal heat energy to the final effect
(D) Pre-heater : Rapidly cools the concentrated fluid product

2025
150. A major disadvantage of operating an evaporator at excessively low vacuum (i.e., absolute pressure is too high) is:
(A) The boiling temperature drops excessively low, risking product freezing
(B) The steam economy of the evaporator system becomes infinitely high
(C) The concentrated milk proteins spontaneously and completely rehydrate
(D) Boiling temperature rises, increasing thermal damage and denaturation risk

2022
151. The normal heat coagulation time (HCT) of bovine milk at 140 °C typically ranges between:
(A) 1 to 2 minutes
(B) 10 to 20 minutes
(C) 60 to 90 minutes
(D) 3 to 5 hours

2015
152. According to the Sommer and Binney salt balance theory, which statement is INCORRECT?
(A) Heat stability is governed by the ratio of stabilizing to destabilizing ions.
(B) Citrate and phosphate balance the effects of calcium and magnesium.
(C) Calcium and magnesium stabilize casein micelles against coagulation.
(D) Disruption of this balance by added acids reduces heat stability.

2021
153. If a batch of milk intended for evaporated milk production exhibits poor heat stability due to excess calcium, the most appropriate chemical intervention is the addition of:
(A) Calcium chloride salt
(B) Concentrated lactic acid
(C) Active rennet enzyme
(D) Disodium phosphate salt

2007
154. Forewarming (pre-heating) milk at 90-95 °C for 10-15 minutes prior to concentration significantly improves subsequent heat stability primarily by:
(A) Complex formation between beta-lactoglobulin and kappa-casein
(B) Completely destroying and removing all somatic cells present
(C) Completely volatilizing all potential feed-related off-flavors
(D) Thermally hydrolyzing lactose into glucose and galactose sugars

2021
155. Type A milk exhibits a heat coagulation time (HCT) - pH profile characterized by:
(A) A continuous and linear increase in HCT values with increasing pH
(B) A pronounced maximum stability at pH 6.7 and a minimum at pH 6.9
(C) A continuous and linear decrease in HCT values with increasing pH
(D) Complete and absolute physical independence from any pH scale changes

2021
156. Heat stability of milk is negatively affected by all of the following EXCEPT:
(A) High levels of colostrum
(B) Forewarming treatments
(C) Increased acidity
(D) High calcium ion activity

2019
157. Compared to concentrated milk, unconcentrated fluid milk requires:
(A) Longer times to coagulate at the same temperature
(B) Lower temperature to coagulate in the same time period
(C) Extensive and mandatory addition of stabilizing salts
(D) Significantly higher homogenization pressures for stability

2004
158. "Heat Coagulation Time" (HCT) is defined as:
(A) The total time required for a milk sample to reach its boiling point
(B) The thermal death time taken to completely destroy Coxiella burnetii
(C) The time needed to induce visible coagulation at a specific high temperature
(D) The exact physical duration of the UHT sterilization holding tube

2001
159. Which of the following pairs accurately matches the salt component with its role in the Sommer-Binney theory?
(A) Citrate : Coagulating agent
(B) Phosphate : Destabilizing/Coagulating agent
(C) Magnesium : Stabilizing agent
(D) Calcium : Destabilizing/Coagulating agent

2010
160. The primary disadvantage of relying heavily on stabilizing salts (like phosphates) to correct heat stability in concentrated milk is:
(A) They rapidly decrease the product pH below 4.0 value
(B) They entirely prevent subsequent enzymatic protein digestion
(C) Risk of sediment or sludge formation during storage
(D) They cause instantaneous and severe Maillard browning

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2005
161. The preservative action in Sweetened Condensed Milk (SCM) is fundamentally achieved by:
(A) Commercial sterilization of the packaged product at 121 °C
(B) Lowering water activity (aw) via high sucrose concentration
(C) Systematic addition of chemical preservatives like sodium benzoate
(D) Initiation of active and controlled lactic acid fermentation

2004
162. Regarding the processing of SCM, which statement is INCORRECT?
(A) It involves adding finely ground lactose powder as a seeding agent.
(B) It aims to produce millions of microscopic crystals under ten microns.
(C) It is designed to prevent the tactile defect known as product sandiness.
(D) It aims to force the formation of a few very large lactose crystals.

2017
163. To ensure microbiological stability, the "sugar ratio" (sucrose in aqueous phase) of SCM should ideally be maintained between:
(A) 20 - 30%
(B) 40 - 50%
(C) 60 - 64.5%
(D) 80 - 90%

2022
164. Age gelation in Sweetened Condensed Milk during prolonged storage is primarily caused by:
(A) Rapid growth and metabolic activity of osmophilic yeasts
(B) Uncontrolled and massive crystallization of added sucrose
(C) Casein micelle interactions and residual plasmin activity
(D) Excessive physical hydration of suspended fat globules

2010
165. The sugar ratio in SCM is calculated using which formula?
(A) $\frac{\%\text{Sucrose}}{\%\text{Sucrose} + \%\text{Water}} \times 100$
(B) $\frac{\%\text{Sucrose}}{\%\text{Total Solids}} \times 100$
(C) $\frac{\%\text{Lactose}}{\%\text{Water}} \times 100$
(D) $\frac{\%\text{Sucrose}}{\%\text{Fat}} \times 100$

2017
166. Standard Sweetened Condensed Milk defects include all of the following EXCEPT:
(A) Lactose sandiness defect
(B) Viscosity-related age gelation
(C) Button formation from mold growth
(D) Syneresis due to rennet action

2025
167. Compared to Evaporated Milk, Sweetened Condensed Milk undergoes:
(A) A much more severe final sterilization process (e.g., in-container retorting)
(B) No severe in-container thermal sterilization due to its osmotic pressure
(C) A process requiring absolute removal of all lactose
(D) Extensive fat fractionation

NODIA

2010
168. "Sandiness" in Sweetened Condensed Milk is defined as a textural defect caused by:
(A) Incomplete physical dissolution of added sucrose
(B) Accidental contamination of product with physical dirt
(C) Lactose crystals exceeding 15-20 μm in size
(D) Presence of denatured whey protein aggregate structures

2016
169. Which of the following pairs correctly matches the Sweetened Condensed Milk (SCM) defect with its primary causative agent?
(A) Buttons : Osmophilic yeasts producing excessive gas
(B) Sandiness : Uncontrolled and rapid sucrose crystallization
(C) Gas formation : Heat-resistant species of Aspergillus
(D) Buttons : Molds forming firm, discolored coagula

2025
170. A major technological advantage of manufacturing SCM over evaporated milk is:
(A) Avoidance of complex thermal sterilization steps
(B) Lower requirement for superior-quality raw milk
(C) Complete physical immunity to oxidative rancidity
(D) Significantly shorter overall mixing times in plant

2018

171. The standard composition of Evaporated Milk (unsweetened) according to international (Codex) standards typically requires a minimum milk fat content of:
(A) 3.0%
(B) 7.5%
(C) 15.0%
(D) 26.0%

2022

172. Regarding the processing of Evaporated Milk, which statement is INCORRECT?
(A) Homogenization is critical to prevent fat separation (creaming) during storage.
(B) The product is preserved by high sugar content rather than heat.
(C) In-container sterilization typically utilizes rotary retorts.
(D) Disodium phosphate is frequently added to stabilize proteins against heat coagulation.

2019

173. During the storage of UHT sterilized concentrated milk, a gradual but irreversible increase in viscosity leading to a custard-like structure is observed. This phenomenon is diagnosed as:
(A) Age gelation
(B) Sandiness
(C) Phase inversion
(D) Lipid autoxidation

2008

174. The Maillard reaction during the intensive retorting of Evaporated Milk primarily causes:
(A) A significant and rapid increase in the product pH
(B) The complete breakdown of all fat into free fatty acids
(C) Development of characteristic brown color and cooked flavor
(D) The physical precipitation of insoluble calcium phosphate

2009

175. The F-value required for commercial sterilization of Evaporated Milk in retorts ensures the destruction of:
(A) All vegetative pathogenic bacterial cells present in milk
(B) All native milk enzymes without any physical exception
(C) The entirety of native lactose and other sugar molecules
(D) Both Clostridium botulinum and resistant thermophilic spores

2007

176. To prevent age gelation in UHT concentrated milk, technologists might employ all of the following strategies EXCEPT:
(A) Addition of specific polyphosphates to the mix
(B) Application of a severe initial forewarming treatment
(C) Complete enzymatic hydrolysis of all casein micelles
(D) Maintaining consistent low-temperature storage conditions

2021

177. Compared to in-container retort sterilization, UHT processing of concentrated milk yields:
(A) A significantly darker brown color in the final product
(B) Higher retention of vitamins and a whiter product color
(C) Much poorer overall microbiological safety and stability
(D) Larger average fat globule sizes in the final emulsion

2023

178. "Creaming" in Evaporated Milk refers to:
(A) The intentional addition of extra cream to the formulation
(B) The progressive browning reaction due to thermal treatments
(C) The rapid and complete physical crystallization of butterfat
(D) Upward physical migration of fat globules during storage

NODIA

2023

179. Which of the following pairs accurately maps the thermal process to its typical time-temperature profile for Evaporated Milk?
(A) In-container sterilization : 115-121 °C for 10-20 min
(B) UHT sterilization : 90 °C for a holding time of 15 min
(C) Forewarming treatment : 140 °C for a duration of 4 sec
(D) Pasteurization process : 121 °C for a hold of 30 min

2005

180. A primary disadvantage of UHT sterilized concentrated milk compared to retorted evaporated milk is:
(A) Significantly inferior initial sensory and color quality of milk
(B) Severe and irreversible destruction of heat-

labile vitamins
(C) Susceptibility to age gelation and enzyme reactivation over storage
(D) Strict necessity of using specialized glass packaging materials

2008
181. In the context of spray drying, the transition of milk from a liquid droplet to a dry particle fundamentally relies on:
(A) Rapid heat and mass transfer via massive surface area generation
(B) Extremely high pressure compressing the internal water into ice
(C) Chemical precipitation of water molecules by stabilizing salts
(D) Gravity-driven mechanical filtration of suspended milk solids

2023
182. Which of the following statements about atomization in spray drying is INCORRECT?
(A) Rotary atomizers utilize a rapidly spinning wheel to shear the liquid into droplets.
(B) Pressure nozzles require high-pressure pumps to force fluid through a small orifice.
(C) Two-fluid nozzles use compressed air or gas to assist in breaking up the liquid stream.
(D) Rotary atomizers are strictly incapable of handling highly viscous, concentrated milk.

2005
183. To maximize the bulk density of spray-dried milk powder, an operator should:
(A) Inject compressed air into the feed milk prior to atomization
(B) Use high feed concentration and minimize entrained air
(C) Lower the total solids concentration of the feed milk to 20%
(D) Drastically increase the inlet drying air temperature in chamber

2006
184. Roller (drum) drying typically results in a milk powder with a lower solubility index than spray drying primarily because:
(A) Roller drying processes operate strictly at freezing or sub-zero temperatures
(B) Roller drying completely and selectively removes all native milk lactose
(C) Direct contact with hot metal surfaces causes severe protein denaturation
(D) Roller dried powder particles are always perfectly spherical in shape

2005
185. The function of the cyclone separator in a spray drying plant is to:
(A) Efficiently atomize the incoming concentrated liquid milk feed
(B) Continuously heat the incoming inlet drying air to high heat
(C) Rapidly cool the finished final powder to a stable four degrees
(D) Separate and recover fine powder particles from exhaust air

2012
186. The drying kinetics of a milk droplet in a spray dryer undergo distinct phases. These include all of the following EXCEPT:
(A) Sublimation period
(B) Constant rate period
(C) Falling rate period
(D) Crust formation

2025
187. Compared to pressure nozzle atomization, rotary atomization generally provides:
(A) A significantly narrower and taller physical drying chamber requirement
(B) Greater flexibility in handling varying feed rates and viscosities
(C) Droplets that are exclusively solid in structure with no internal voids
(D) Complete and absolute elimination of fine particles from the chamber

2019
188. In drying physics, the "falling rate period" is defined as the phase where:
(A) The surface of the droplet is fully saturated with free water
(B) Internal moisture diffusion becomes the limiting factor for evaporation
(C) The drying air temperature rapidly drops to ambient levels
(D) Powder actively exits from the base of the cyclone separator

2019
189. Which of the following pairs a drying technology with a characteristic physical property of its resulting milk powder?
(A) Spray drying : Excellent solubility and flowability
(B) Spray drying : Scraped, flaky particle structure
(C) Roller drying : Highly spherical particles with internal vacuoles
(D) Freeze drying : High degree of protein

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denaturation

2005

190. A major disadvantage of roller drying compared to spray drying is:
(A) Significantly higher capital and installation costs for small capacities
(B) Inability to dry high-fat products
(C) High degree of Maillard browning and cooked flavor
(D) Excessive consumption of electrical power for atomization

2002

191. According to standard quality parameters, the maximum permissible moisture content for standard Skimmed Milk Powder (SMP) is generally around:
(A) 1.0 - 2.0%
(B) 3.0 - 4.0%
(C) 7.0 - 8.0%
(D) 10.0 - 12.0%

2007

192. Regarding the free fat content in Whole Milk Powder (WMP), which statement is INCORRECT?
(A) High free fat content impairs the flowability of the powder.
(B) Free fat is highly susceptible to rapid and destructive autoxidation.
(C) Intensive homogenization prior to drying eliminates all free fat.
(D) Free fat limits the sinkability and wettability of non-instantized WMP.

2021

193. If a batch of Skimmed Milk Powder (SMP) registers a high Insolubility Index (> 1.5 ml), the most likely processing error was:
(A) Drying feed milk with an excessively low solids concentration
(B) Excessive heat treatment during evaporation or drying
(C) Adding liquid lecithin during the post-drying agglomeration
(D) Operating the primary cyclone separator at extremely low speeds

2004

194. The presence of high levels of occluded air (vacuoles) inside spray-dried powder particles directly causes:
(A) A permanent increase in the powder bulk density
(B) Immediate and spontaneous coagulation of the native proteins
(C) Significantly enhanced and accelerated Maillard browning rates
(D) Reduced bulk density and increased oxidation susceptibility

2002

195. Bulk density of milk powder is expressed in units of:
(A) g / ml or kg / m^3
(B) g / 100g
(C) ml / g
(D) centipoise (cP)

2018

196. Factors that typically increase the bulk density of spray-dried milk powder include all of the following EXCEPT:
(A) Increasing the feed solids concentration of the milk
(B) De-aeration of the feed concentrate during processing
(C) Nitrogen gas injection prior to atomization
(D) Decreasing the outlet air temperature of the dryer

NODIA

2002

197. Compared to Skimmed Milk Powder (SMP), Whole Milk Powder (WMP) exhibits:
(A) Susceptibility to oxidative rancidity due to milk fat presence
(B) A significantly longer shelf life under ambient storage conditions
(C) A much higher concentration of lactose sugar per hundred grams
(D) Complete chemical resistance to subsequent Maillard browning reactions

2006

198. The "Insolubility Index" of milk powder is determined by:
(A) Measuring the physical time required for ten grams of powder to wet
(B) Titrating the recovered dissolved proteins with a standard organic acid
(C) Passing the dry powder through a standardized physical testing sieve
(D) Measuring the volume of undissolved sediment after centrifugation

2022

199. Which of the following accurately pairs a milk powder defect with its primary chemical cause?
(A) Tallowy flavor : Intensive and rapid progress of Maillard browning
(B) Caking : Moisture absorption leading to

lactose crystallization
(C) Scorched particles : Exceptionally high moisture in final package
(D) Caramelization : Spontaneous and rapid pathway of lipid oxidation

2007
200. What is the primary disadvantage of storing WMP in standard air-filled packaging?
(A) Rapid and irreversible physical staling of the core proteins
(B) Instantaneous and complete chemical destruction of all vitamins
(C) Oxidized off-flavor development, requiring inert gas flushing
(D) Significant and continuous loss of product bulk density over time

2011
201. The process of agglomeration in milk powder production primarily aims to improve:
(A) Product storage shelf life
(B) Total percentage of fat content
(C) Protein nutritional value profile
(D) Dispersibility and instant properties

2019
202. Regarding the instantization of Whole Milk Powder (WMP), which statement is INCORRECT?
(A) Agglomeration alone is sufficient to make WMP fully instant.
(B) Lecithin is typically sprayed onto the powder surface to improve wettability.
(C) WMP relies on lecithin to overcome the hydrophobicity of surface free fat.
(D) Fluid bed processing is common for both agglomeration and lecithin application.

2018
203. To accurately assess the instant properties of a dairy whitener, one should evaluate its:
(A) The active titratable acidity levels along with the actual pH
(B) Wettability, sinkability, dispersibility, and solubility
(C) Standard Reichert Meissl numbers and core Polenske values
(D) The thermal heat coagulation time under specific temperatures

2021
204. Applying a fine mist of water or steam to dry milk powder in a fluid bed causes:
(A) Immediate initiation of destructive lipid oxidation reactions
(B) Surface stickiness, causing particles to adhere into porous agglomerates
(C) Complete physical destruction of all active native milk enzymes
(D) Total and instantaneous crystallization of the remaining fat phase

2012
205. Lecithinization of milk powder is most commonly achieved by:
(A) Spraying soy lecithin dissolved in butter oil onto powder in a fluid bed
(B) Adding high-purity liquid lecithin directly to raw milk prior to pasteurization
(C) Blending dry lecithin powder with dry milk powder utilizing a ribbon blender
(D) Boiling the finished dry milk powder continuously inside a hot lecithin bath

2016
206. The physical properties of an instantized milk powder typically include all of the following EXCEPT:
(A) Increased particle size
(B) High interstitial porosity
(C) Very high bulk density
(D) Rapid capillary penetration of water

2025
207. Compared to standard non-instant SMP, instantized SMP requires:
(A) Smaller, more compact particles
(B) The necessary addition of surface-active agents like lecithin
(C) Drying at much lower inlet temperatures
(D) Agglomeration to create a porous, clustered structure

2004
208. "Wettability" in the context of instant milk powder is defined as:
(A) The physical tendency of the dry powder to spontaneously form large lumps
(B) The total amount of water molecules held within the lactose crystal matrix
(C) The ability of particles to overcome surface tension and penetrate water
(D) The thermodynamic rate at which native milk proteins denature in hot water

2018
209. Which of the following pairs correctly matches the instantization parameter with its functional mechanism?
(A) Agglomeration : Coats fat with a hydrophilic layer

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(B) Sinkability : The rate at which wetted particles drop through the liquid profile
(C) Lecithinization : Creates large porous clusters for water to enter via capillary action
(D) Dispersibility : Measures the amount of insoluble scorched particles

2024
210. A minor physical disadvantage of instantized agglomerated milk powder is:
(A) Complete and absolute physical insolubility in cold water profiles
(B) The development of an intense and unpleasant bitter flavor note
(C) A strict and mandatory necessity to be stored in stable liquid form
(D) High mechanical fragility, causing breakdown into dust during transport

2010
211. The fundamental objective in humanizing bovine milk for infant formula is to:
(A) Adjust macronutrient and micronutrient profiles to match human breast milk
(B) Perfectly match the exact sensory flavor profile of natural human milk
(C) Completely eradicate all types of proteins to prevent infant allergies
(D) Increase the native casein micelle concentration to a significant level

2012
212. Regarding the protein profile adjustment in infant formulas, which statement is INCORRECT?
(A) Bovine milk has a higher casein-to-whey protein ratio than human milk.
(B) Humanizing involves adding demineralized whey to increase whey proteins.
(C) Standard bovine milk inherently possesses a 60:40 whey-to-casein ratio.
(D) The target whey-to-casein ratio for standard infant formula is typically 60:40.

2016
213. To closely mimic the lipid profile of human milk, which is rich in unsaturated fatty acids, an infant formula manufacturer must:
(A) Replace bovine milk fat with vegetable oil blends
(B) Exclusively utilize highly fractionated hard stearin fractions
(C) Completely hydrogenate the native milk fat under high pressure
(D) Remove all lipid and fat fractions entirely from the formula

NODIA

2012
214. Demineralization of whey prior to its addition to infant formula is essential because:
(A) Standard bovine whey lacks sufficient levels of bioavailable calcium
(B) High mineral concentrations strictly prevent the drying of liquid whey
(C) It induces immediate and uncontrolled lipid oxidation in the formula
(D) The high mineral ash content of bovine whey would overload infant kidneys

2002
215. Carbohydrate modification in standard infant formulas primarily involves:
(A) The complete and absolute physical removal of all native lactose
(B) Adding lactose to match the high carbohydrate content of human milk
(C) The substitution of native lactose with high-fructose corn syrup
(D) The extensive and regular use of chemically resistant starches

2012
216. Advanced formulation of infant formulas often incorporates functional additives to mimic human milk benefits. These include all of the following EXCEPT:
(A) Arachidonic acid (ARA) and Docosahexaenoic acid (DHA)
(B) Prebiotic oligosaccharides (GOS/FOS)
(C) Live attenuated viral vaccines
(D) Nucleotides

2009
217. Compared to bovine milk, mature human breast milk contains:
(A) Significantly higher protein, lower lactose, and lower fat content
(B) Almost identical and completely matching mineral profiles in both
(C) The presence of exclusively beta-lactoglobulin whey fractions
(D) Lower total protein, higher lactose, and distinct immunoglobulins

2003
218. "Weaning foods" (complementary foods) are formally defined as:
(A) Complementary foods introduced during transition from milk diet to family foods
(B) Specialized powdered formulas designed primarily for premature infant feeding

(C) Complete breast milk substitutes used exclusively for the first six months
(D) Intravenous nutritional sera and sterile solutions used in clinical care

2011

219. Which of the following pairs correctly matches the formulation adjustment with its physiological rationale in infants?
(A) Adding DHA/ARA : Enhances infant renal solute load handling
(B) Lowering total protein : Prevents metabolic and renal stress
(C) Adding vegetable oils : Actively promotes lactose digestion
(D) Adding iron : Directly prevents lipid oxidation in powder

2022

220. A major technological challenge in manufacturing liquid ready-to-feed infant formulas compared to powdered formulas is:
(A) Complete and absolute technological inability to supplement essential vitamins
(B) Maintaining physical emulsion stability and preventing age gelation during storage
(C) Dealing with excessively high bulk density of the liquid during packaging
(D) The absolute physical impossibility of executing standard homogenization

2008

221. The primary biochemical process that occurs during the malting of barley for malted milk foods is:
(A) Germination, activating amylolytic enzymes to hydrolyze starches
(B) Complete conversion of proteins into pure free amino acids
(C) Active anaerobic fermentation of fermentable sugars into alcohol
(D) High-temperature thermal caramelization of available sugars

2014

222. Which of the following statements about malted milk manufacture is INCORRECT?
(A) The liquid malt extract is combined with milk solids and vacuum dried
(B) The mashing process allows active enzymes to break starches into dextrins
(C) Malted milk powder requires high pressure spray drying for its texture
(D) Vacuum pan or band dryers are traditionally used to produce porous structures

2019

223. If the mashing temperature during malt extraction exceeds 80 °C prematurely, the likely result is:
(A) Significantly enhanced total fermentable sugar yield
(B) Rapid multiplication of thermophilic lactic acid bacteria
(C) Spontaneous crystallization of newly formed maltose sugars
(D) Denaturation of diastatic enzymes, halting starch hydrolysis

2018

224. The use of vacuum drying in malted milk food production primarily ensures:
(A) The rapid physical formation of an extremely dense, heavy powder
(B) Total and instantaneous chemical destruction of all essential vitamins
(C) Expansion of the product into a porous, honeycomb-like structure
(D) Complete and intense Maillard browning reactions yielding a black color

2008

225. According to FSSAI standards, malted milk food must contain a minimum percentage of milk solids. This minimum is typically around:
(A) 2%
(B) 7-8%
(C) 40%
(D) 75%

2006

226. The traditional mashing process for malt extract involves all of the following steps EXCEPT:
(A) Mixing crushed malt with water
(B) Controlled temperature resting phases
(C) Filtration to separate the sweet wort from the spent grains
(D) Distillation to extract volatile alcohols

2008

227. Compared to standard spray-dried dairy powders, vacuum-band dried malted milk powder exhibits:
(A) A highly hygroscopic, irregular, and crumbly texture
(B) A perfectly uniform and spherical particle structure
(C) Consistently high bulk density in the final powder
(D) Complete and zero physical solubility in warm milk

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2007

228. In malting and brewing terminology, "wort" refers to:

(A) The completely discarded fibrous husk of the malted barley grain

(B) The intermediate dried milk powder prior to final retail packaging

(C) Sweet, enzymatically extracted liquid containing maltose and dextrins

(D) The highly concentrated fat fraction separated during processing

2004

229. Which of the following pairs accurately links the raw material with its function in malted milk foods?

(A) Barley malt : Source of amylases and distinct flavor

(B) Wheat flour : Primary source of active diastatic enzymes

(C) Whole milk : Provides complex carbohydrates

(D) Cocoa powder : Provides structural protein network

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2013

230. A major disadvantage of the highly porous structure of vacuum-dried malted milk powder is its:

(A) Total and absolute physical inability to absorb any added flavors during mixing

(B) Highly increased resistance to metabolic and enzymatic digestion in the gut

(C) Complete physical inability to easily dissolve inside standard hot liquids

(D) Extreme hygroscopicity, requiring moisture-proof packaging to prevent collapse

****

ANSWERS

1. (D) Phosphatidylethanolamine
Phosphatidylethanolamine is the most abundant phospholipid class present in the milk fat globule membrane. It typically accounts for over thirty percent of the total polar lipids in the membrane structure. This specific lipid plays a vital role in maintaining membrane fluidity and stability, which prevents the coalescence of the fat globules suspended in milk.

2. (B) 3.7 to 4.1
The intact milk fat globule membrane exhibits an isoelectric point within this acidic range because of the complex mixture of proteins and polar lipids coating the globules. At this specific hydrogen ion concentration, the net electrical charge on the membrane surface becomes zero, leading to reduced electrostatic repulsion and increased susceptibility to aggregation.

3. (A) Both A and R are true and R is the correct explanation of A.
The milk fat globule membrane naturally stabilizes fat droplets in the aqueous milk plasma. The constituent membrane proteins and polar lipids possess both hydrophilic and lipophilic regions, creating an amphiphilic barrier. This structural arrangement lowers the interfacial tension at the oil-water interface, preventing individual fat globules from coalescing into a single phase.

4. (A) Arachidonic acid
Arachidonic acid is a polyunsaturated long-chain fatty acid containing twenty carbon atoms and four double bonds. In contrast, bovine milk fat is characterized by a significant proportion of short-chain fatty acids like butyric, caproic, and caprylic acids. These smaller molecules are synthesized in the mammary gland and contribute directly to milk fat flavor and fluidity.

5. (A) I and II
Butyrophilin represents the most prominent integral membrane protein spanning the lipid bilayer of the milk fat globule. Similarly, xanthine oxidase is a highly abundant peripheral metalloenzyme associated with the inner layer. However, casein micelles are main proteins of the skim milk phase rather than acting as the primary structural framework of the membrane.

6. (B) Elevated melting point and harder texture
Unsaturated fatty acids possess double bonds that create kinks in their carbon chains, keeping them liquid at room temperature. Reducing their concentration relative to saturated fatty acids increases the packing efficiency of the lipid molecules. This structural change raises the solid fat content, leading to an elevated melting point and a harder physical texture.

7. (C) Stearic acid : 69.6 °C
Stearic acid is an eighteen-carbon fully saturated fatty acid with a melting point of approximately sixty-nine point six degrees Celsius. Shorter saturated chains or unsaturated chains like butyric, oleic, and linoleic acids have much lower melting points due to reduced molecular weight or chain bends. Consequently, stearic acid contributes heavily to high-melting fat fractions.

8. (C) sn-3 position
Bovine milk fat exhibits a highly ordered and asymmetrical distribution of fatty acids on the glycerol backbone. Stereospecific analysis demonstrates that butyric acid, along with other short-chain fatty acids, is almost exclusively esterified at the outer sn-three position. This unique placement directly influences the crystallization properties and digestibility of the dairy lipids.

9. (C) P-3, Q-4, R-1, S-2
The milk fat globule membrane contains diverse constituents with specialized functions. Xanthine oxidase is a metalloenzyme generating reactive oxygen species, while sphingomyelin is a major polar lipid containing a ceramide backbone. Mucins are complex glycoproteins providing critical steric repulsion to stabilize droplets, and butyrophilin is an integral protein interacting directly with the inner monolayer coat.

10. (B) Broadening of the melting range
Milk fat consists of a highly heterogeneous mixture of triglycerides composed of short, medium, and long-chain fatty acids. Because short-chain fatty

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acids have low melting temperatures and long-chain saturated acids have high melting points, their co-existence broadens the melting range of milk fat. This allows it to remain semi-solid over a wide temperature interval.

11. (C) Beta (β)
Triacylglycerols can crystallize into three primary polymorphic forms, with the beta polymorph being the most thermodynamically stable. This form possesses the tightest triclinic parallel packing arrangement and the highest melting point. In contrast, the alpha form is unstable and transient, while the beta prime form is intermediate in stability and provides desirable texture.

12. (A) Nuclear Magnetic Resonance (NMR)
Pulsed nuclear magnetic resonance is the standard non-destructive technique for determining solid fat content. This method exploits the difference in proton relaxation times between liquid and solid phases within the fat sample. It provides highly precise and rapid quantitative measurements across various temperatures, which is essential for characterizing the plasticity and performance of spreads.

13. (C) Beta crystals exhibit a loosely packed, subcell hexagonal structure.
Crystallization polymorphs exhibit distinct packing configurations. The alpha polymorph is characterized by a loosely packed, subcell hexagonal structure, which represents the least stable crystal form. Conversely, beta prime crystals feature an intermediate orthorhombic packing, and the highly stable beta crystals are defined by a dense, parallel triclinic subcell rather than a loose hexagonal arrangement.

14. (A) Both A and R are true and R is the correct explanation of A.
The rheological behavior of butter depends on the solid to liquid fat ratio at use temperatures. A higher proportion of solid crystals limits the movement of the fat network and reduces the volume of the continuous liquid oil phase. Without sufficient liquid phase acting as a lubricant, the butter lacks structural plasticity, impairing its spreadability.

15. (C) Palmitic acid
Palmitic acid is a sixteen-carbon saturated fatty acid that dominates the high-melting triglyceride fraction of milk fat. Triglycerides rich in palmitic acid crystallize easily at higher temperatures, forming a solid network. This fraction plays a vital role in providing structural integrity, heat resistance, and appropriate physical hardness to butter and related dairy spreads.

16. (C) I and III
Cone penetrometry is a primary rheological technique used to measure the hardness, yield stress, and work of softening in butter. Isothermal crystallization under standard conditions produces multiple polymorphs rather than solely yielding the beta form. Furthermore, the thermodynamic transition from the beta prime to the beta polymorph is an exothermic process, not an endothermic one.

17. (D) Greater triglyceride diversity and molecular asymmetry
Cocoa butter consists of a highly homogeneous population of symmetrical triglycerides, which facilitates rapid crystallization into stable beta forms. In contrast, milk fat contains hundreds of different triacylglycerols with highly asymmetrical fatty acid distributions. This extreme molecular diversity and structural asymmetry hinder neat molecular packing, reducing the overall rate and extent of beta crystal formation.

18. (A) The minimum force required to initiate flow
Yield stress is a fundamental rheological parameter that defines the limit of plastic behavior in fat networks like butter. It represents the minimum threshold of mechanical force or shear stress that must be applied to disrupt the crystalline network and initiate flow. Below this value, the material behaves as an elastic solid under applied load.

19. (A) P-3, Q-2, R-4, S-1
Different analytical methods evaluate specific structural properties of milk fat. Differential scanning calorimetry measures heat flow to resolve melting and crystallization enthalpies, while pulsed nuclear magnetic resonance quantifies solid fat content. Cone penetrometry determines rheological traits like yield stress and hardness, and X-ray diffraction resolves the spacing of crystal polymorphs such as alpha or beta.

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20. (B) Rapid cooling to 6 °C, warming to 20 °C, then cooling to 12 °C
The Alnarp temperature treatment optimizes the solid-to-liquid fat ratio in butter. Rapid cooling to six degrees Celsius initiates abundant crystallization. Warming to twenty degrees Celsius melts the lowest-melting crystal fractions and releases liquid oil from the crystal network. Subsequent cooling to twelve degrees Celsius locks this liquid oil within a stable, highly spreadable crystal network.

21. (D) Square of the fat globule diameter
Stokes' law mathematically defines the rate of sedimentation or creaming of suspended droplets under gravitational or centrifugal forces. The terminal velocity of the fat globules is directly proportional to the square of their diameter and the density difference. Consequently, larger fat globules separate much more rapidly than smaller ones, which dictates commercial separator design and efficiency parameters.

22. (C) I, II and III
Neutralization of sour cream prevents high fat losses in buttermilk and avoids soapy off-flavors from over-neutralization. Sodium bicarbonate is a common neutralizing agent that releases carbon dioxide during reaction with lactic acid. Conversely, cream ripening for butter production is conducted at cool temperatures to encourage fat crystallization and bacterial flavor production, rather than high temperatures.

23. (C) Citrate
Diacetyl is the primary aroma compound responsible for the characteristic buttery flavor of cultured dairy products. Starter bacteria metabolize citrate present in the milk plasma to produce alpha-acetolactate, which is subsequently decarboxylated to diacetyl. Since lactose metabolism primarily yields lactic acid, citrate utilization is essential for achieving the desired aromatic quality in the finished butter.

24. (A) Both A and R are true and R is the correct explanation of A.
Centrifugal separation of cream depends directly on the viscosity of the continuous plasma phase. As milk temperature drops below thirty-five degrees Celsius, the viscosity of the water and protein phase increases significantly. This increased drag force severely restricts the movement of fat globules toward the center of the centrifuge, reducing the overall separation efficiency.

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25. (A) Casein precipitation by lime, leading to higher fat loss in buttermilk
Calcium hydroxide introduces excess divalent calcium ions into the cream. These ions interact with casein micelles, promoting their aggregation and premature precipitation. When the aggregated protein precipitates, it physically entrains fat globules and interferes with the normal churning process. This disruption leads to elevated fat loss in the resulting buttermilk, reducing overall yield.

26. (B) Complete desorption of outer MFGM proteins
Aging and ripening of cream promote the progressive hydration of milk proteins and the controlled crystallization of core fat. These physical changes weaken the membrane structure to facilitate churning. However, complete desorption of the outer membrane proteins does not occur, as some membrane integrity is maintained until the mechanical shear of churning.

27. (B) Separation → Standardization → Neutralization → Pasteurization → Ripening/ Aging
The standard preparation sequence ensures safety and quality. Cream is separated from whole milk and standardized to the target fat content. Neutralization of acidity follows, preventing heat-coagulation during the subsequent pasteurization step. Pasteurization eliminates pathogens and inactivates lipases, preparing the cream for subsequent controlled biological ripening and physical aging before the churning.

28. (A) The residual fat content in the skim milk
Skimming efficiency indicates how effectively a centrifugal separator removes fat globules from whole milk. It is quantitatively measured by the residual concentration of fat remaining in the skim milk phase after processing. Lower residual fat values indicate higher separator performance, reflecting successful recovery of the maximum possible cream volume under standard operating conditions.

29. (A) P-3, Q-4, R-2, S-1
Specific processing steps target different functional changes in cream. Forewarming reduces milk viscosity to enhance separation efficiency. Adding a lactic starter culture drives fermentation to develop critical buttery aroma compounds. Cool storage at ten degrees Celsius encourages optimal beta prime fat crystallization, and vacuum treatment is utilized to strip away any undesirable volatile off-flavors.

30. (C) Having an adequate proportion of solid fat (typically 30-45%) in the cream
Minimizing fat loss in buttermilk requires a specific ratio of solid to liquid fat. If the cream contains insufficient solid fat, the globules collapse completely, releasing excessive liquid fat into the serum phase where it remains unrecovered. Maintaining thirty to forty-five percent solid fat provides structural support during churning, ensuring clean phase inversion and optimal yield.

31. (C) Lower cream fat concentrations (around 30-35%)
Traditional batch churning utilizes cream with lower fat concentrations, typically around thirty to thirty-five percent, to allow proper aeration and cascade movement within the large rotating vessel. Continuous Fritz processes operate at much higher speeds under high-shear forces, allowing them to efficiently process highly concentrated cream containing up to fifty percent milk fat.

32. (B) An oil-in-water emulsion converts to a water-in-oil emulsion
Cream is naturally structured as an oil-in-water emulsion, where fat globules are dispersed throughout the continuous aqueous plasma phase. The mechanical action of churning disrupts the milk fat globule membranes, releasing liquid fat. This free fat eventually forms a continuous lipid phase that traps water droplets, completing the phase inversion to a water-in-oil emulsion.

33. (C) A is true but R is false.
Continuous butter churns allow precise adjustments to the moisture content of the finished butter by continuously injecting water into the working section. The statement regarding fixed speeds is incorrect because modern continuous machines feature fully adjustable speeds for both the churning cylinder and the texturizing screws, enabling the controlled expulsion of buttermilk.

34. (A) $\left[\frac{\text{Weight of butter} - \text{Weight of fat}}{\text{Weight of fat}}\right] \times 100$
Overrun in butter represents the increase in the weight of finished butter compared to the weight of milk fat utilized. This increase is due to the incorporation of moisture, salt, curd, and air. Mathematically, it is calculated by subtracting the fat weight from the butter weight, dividing by the fat weight, and multiplying by one hundred.

35. (C) II and III
A primrose defect is a dark surface color caused by dehydration. However, the fishy flavor defect is caused by the chemical breakdown of lecithin into trimethylamine under acidic conditions, not by cholesterol autoxidation. Furthermore, a mottled appearance is due to uneven salt distribution and moisture migration during the working, rather than microbial contamination.

36. (A) Thorough working to finely disperse moisture
A leaky body defect occurs when water droplets in butter are large and poorly bound, allowing moisture to seep out during storage. To prevent this issue, the butter must undergo thorough mechanical working. This process breaks up large water droplets into microscopic sizes and distributes them uniformly throughout the continuous fat crystal matrix, stabilizing the emulsion.

37. (B) III → II → I → IV
In the continuous Fritz butter making process, high-speed agitation in the churning cylinder first destabilizes the fat globules. The resulting mixture of butter grains and serum then enters the separation stage to drain the buttermilk. Next, mechanical screws perform the working and texturizing, followed by final dosing of moisture and salt to standardize composition.

38. (B) Rapid onset of oxidative rancidity
Air incorporation introduces atmospheric oxygen directly into the fat matrix of the cream. Oxygen acts as a primary reactant for lipid autoxidation, attacking unsaturated fatty acids at their double bonds. This oxidation cascade generates unstable hydroperoxides and volatile carbonyl compounds, resulting in the rapid onset of off-flavors associated with oxidative rancidity in the finished butter.

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39. (B) P-2, Q-1, R-4, S-3
The mechanics of churning are explained by historical scientific theories. Fischer and Hooker proposed the phase inversion theory, describing the transition from oil-in-water to water-in-oil. Rahn developed the foam theory, emphasizing the role of air bubbles in concentrating fat. King detailed the fat globule agglomeration concept, and Van Dam contributed to surface adsorption studies.

40. (D) Proteases
A cheesy flavor defect in butter indicates protein breakdown, or proteolysis, within the milk plasma phase during cream storage. Proteases degrade casein and whey proteins into bitter peptides and volatile nitrogenous compounds that resemble mature cheese aromas. Lipases, by contrast, hydrolyze lipids to release free fatty acids, which cause a distinct butyric or soapy rancidity.

41. (A) Buttermilk serum (moisture)
The pre-stratification method exploits gravity separation at a specific temperature. Heating butter to around eighty degrees Celsius for thirty minutes separates it into three distinct layers. Pure milk fat floats to the top, curd particles form an intermediate layer, and the bottom layer consists of buttermilk serum containing the vast majority of the moisture and soluble solids.

42. (B) Browning of milk solids-not-fat
During the creamery butter method, heating is strictly regulated during the initial melting phase. Uncontrolled high temperatures promote rapid Maillard browning reactions between lactose and proteins present in the milk solids-not-fat. Minimizing this premature browning prevents the development of an excessively dark color and a strong burnt flavor, ensuring the desired golden-yellow color of ghee.

43. (A) Both A and R are true and R is the correct explanation of A.
The traditional desi method of ghee production involves a natural fermentation step that yields higher concentrations of protective compounds. When this cultured mass is heated, proteins undergo thermal denaturation in the presence of active lipid phases. This reaction releases active antioxidant sulfhydryl groups, which act as radical scavengers and provide superior oxidative stability over direct cream heating.

44. (A) Indole
The rich and characteristic flavor of ghee is composed of multiple volatile organic compounds formed during heating. Carbonyls, lactones, and free fatty acids contribute directly to its pleasant caramelized and buttery aroma profile. Indole, by contrast, is a nitrogenous compound associated with fecal or bacterial decomposition defects and is not a normal contributor to ghee flavor.

45. (A) I and II
Lipid autoxidation proceeds via a radical chain mechanism comprising initiation, propagation, and termination. Statements representing this process as anything other than a three-stage radical chain are incorrect, as are those misidentifying the primary and secondary oxidation markers. Hydroperoxides are indeed the primary unstable products, and metals like copper accelerate the initiation phase.

46. (D) Denatured proteins, lactose, and phospholipids
Ghee residue is the solid byproduct obtained after the thermal clarification of butter or cream. Its structural matrix consists primarily of denatured milk proteins, caramelized lactose, and complex phospholipids derived from the fat globule membrane. These components aggregate and separate from the liquid fat phase during heating, forming a nutrient-rich, dark brown solid residue.

47. (C) RM value: Varies by state (minimum 21-28)
The Reichert-Meissl value is a crucial parameter used to detect adulteration in milk fat. FSSAI standards establish state-wise RM limits ranging from a minimum of twenty-one to twenty-eight, accounting for regional variations in cattle diets and breeds. Other parameters like moisture are strictly limited to zero point five percent, which is lower than some common misconceptions.

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48. (B) Intense Maillard reactions yielding a burnt flavor
Exceeding one hundred and twenty degrees Celsius during ghee clarification triggers rapid and intense Maillard reactions. These chemical reactions occur between residual reducing sugars like lactose and amino acids from milk proteins. This excessive heating generates high levels of volatile furans and pyrazines, which impart an undesirable burnt flavor and an overly dark color to the ghee.

49. (A) P-2, Q-3, R-4, S-1
Ghee processing methods yield distinct product attributes. The traditional desi method relies on fermented curd to produce a characteristic lactic aroma. The direct cream method heats high-fat cream, producing darker colors due to abundant serum solids. The creamery butter method melts unsalted butter, and the pre-stratification method separates serum by gravity, significantly reducing evaporation energy.

50. (A) Higher thermal energy required to evaporate moisture
The direct cream heating method uses raw cream containing up to fifty percent water. Because there is no gravity separation or physical drainage step, all of this water must be completely evaporated by continuous heating in the boiling vessel. This makes the process highly energy-intensive and thermally demanding compared to the efficient pre-stratification method.

51. (C) Crystallization based on melting points
Dry fractionation is a thermal separation process that isolates different triglyceride groups without using solvents or detergents. It operates by slowly cooling melted milk fat to specific temperatures. This cooling causes high-melting-point triglycerides to crystallize first, forming solid crystals that can be physically separated from the remaining liquid triglycerides by pressure filtration.

52. (A) It is the most widely adopted method for edible dairy products globally.
Solvent fractionation provides highly efficient lipid separations but is not the most widely adopted commercial method for edible dairy fats due to high solvent recovery costs and consumer preference for natural processes. Dry fractionation remains the dominant global industrial practice because it does not introduce organic solvents, ensuring a completely clean and natural product label.

53. (D) Centrifugal separation using a surfactant
Aqueous fractionation, or detergent fractionation, separates crystallized stearin from liquid olein by using a surfactant solution. The surfactant wets the solid fat crystals, making them hydrophilic and encouraging them to suspend in the aqueous phase. Centrifugal separation is then applied to cleanly divide the lighter liquid olein phase from the heavier solid-crystal water slurry.

54. (B) The liquid phase enriched in unsaturated lipids
During milk fat fractionation, cooling drives the crystallization of saturated, high-melting-point triglycerides into a solid mass. The remaining uncrystallized liquid fraction is known as olein. Olein is highly enriched in unsaturated, low-melting-point fatty acids like oleic acid, which ensures it remains completely liquid and highly fluid at ambient and lower storage temperatures.

55. (B) I and II
Tailored milk fat fractions provide specific functional properties in food formulations. High-melting stearin fractions enhance the flakiness of pastries, while low-melting olein fractions improve the spreadability of cold butter. However, middle-melting fractions are not avoided; they are widely incorporated into chocolate formulations to prevent bloom and modify their overall melting characteristics.

56. (B) II, III and IV
Claims that solvent fractionation has lower separation efficiency than dry methods are incorrect. Furthermore, the assertion that stearin contains more unsaturated fatty acids than olein is false, as is the statement that detergent fractionation relies on high temperatures to hydrolyze milk fat. Dry fractionation operates without solvents, and super-olein remains fluid at low temperatures.

57. (A) Entrainment of olein within stearin crystals
During dry fractionation, high-melting-point stearin crystals grow in a viscous, continuous medium of liquid olein. As these crystals form and aggregate, they physically trap and entrain significant volumes of the liquid olein within their crystalline structure. This physical entrainment prevents clean separation, leading to lower yield and reduced purity compared to solvent-assisted systems.

58. (B) Super-olein
Super-olein is a highly specialized liquid fraction of milk fat obtained through multi-step cool fractionation. This fraction is depleted of saturated triglycerides and highly enriched in low-melting-point triacylglycerols. Because of this composition, it remains completely clear and fluid without crystallizing at standard refrigeration temperatures, making it ideal for premium liquid oil applications.

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59. (B) Increased solubility in cold ethanol
The stearin fraction of milk fat consists primarily of saturated, high-melting-point triglycerides with long carbon chains. Because of their highly hydrophobic nature and tight molecular packing, these molecules exhibit very low solubility in cold ethanol. Consequently, increased solubility in cold alcohol is not characteristic of stearin, which instead exhibits elevated solid fat content and hardness.

60. (A) No chemical residues, preserving a clean label
Dry fractionation relies entirely on controlled heating, cooling, and mechanical filtration to separate milk fat fractions. Because this physical process requires no organic solvents or chemical detergents, it eliminates the risk of toxic chemical residues in the final food products. This enables manufacturers to preserve a completely clean, natural, and consumer-friendly ingredient label.

61. (C) Scraped-surface heat exchanger
The scraped-surface heat exchanger, commonly referred to as a Votator, is the primary equipment used in industrial margarine production. It simultaneously cools the liquid fat mixture and applies intense mechanical shear forces. This dual action rapidly crystallizes the lipid phase while dispersing the aqueous phase into microscopic droplets, forming a stable water-in-oil emulsion.

62. (D) Carbohydrate-based (e.g., Maltodextrin)
Carbohydrate-based fat replacers like maltodextrins, modified starches, and gums function primarily through their exceptional water-binding capacity. When hydrated, they form a highly cohesive gel matrix that physically mimics the lubricity, viscosity, and mouthfeel of natural dietary lipids. This allows food formulators to significantly reduce caloric density while maintaining acceptable product quality and texture.

63. (C) Microbiological decay due to higher moisture
Low-fat spreads contain a much higher proportion of water relative to traditional butter, often exceeding fifty percent moisture. This high water activity creates an environment that is highly conducive to the growth of spoilage molds, yeasts, and bacteria. Consequently, preventing microbiological decay represents a major technological challenge, requiring strict preservation methods and clean processing.

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64. (B) Incorporating a hydrocolloid stabilizer
Syneresis in low-fat dairy spreads occurs when the continuous lipid matrix fails to completely entrap and immobilize the excessive aqueous phase. Incorporating a hydrocolloid stabilizer like gelatin or pectin resolves this issue by binding free water and increasing the viscosity of the aqueous droplets. This stabilization prevents droplet coalescence, improving structural integrity and shelf stability.

65. (D) Olestra : Cross-linked starch derivative
Olestra is a lipid-based fat replacer composed of sucrose molecules esterified with six to eight long-chain fatty acids. This unique chemical structure prevents human digestive enzymes from breaking it down, yielding zero calories. It is not a starch derivative, which contrasts with carbohydrate-based fat replacers that are derived from modified starches or polymers.

66. (C) I, II and IV
Emulsions are thermodynamically unstable systems requiring emulsifiers like monoglycerides to lower interfacial tension. Applying high-shear mixing during cooling facilitates the formation of small, stable water droplets within the continuous fat phase. However, increasing fat globule size does not prevent coalescence; rather, smaller droplet sizes are essential for preventing phase separation and maintaining spread texture.

67. (C) Emulsion preparation → Votator processing → Resting/Pin-working → Packaging
Industrial margarine production follows a precise processing sequence. First, the oil and aqueous phases are blended during emulsion preparation. This mixture then undergoes Votator processing, which rapidly cools and shears the fluid. The product is then subjected to resting and pin-working to allow crystal growth and build plasticity, before final automated product packaging.

68. (A) Resistant to pancreatic lipases
A dietary lipid-based fat replacer delivers zero calories because the human digestive system is incapable of absorbing or metabolizing it. This is typically achieved by designing a molecular structure that is fully resistant to pancreatic lipases. Consequently, these molecules pass through the gastrointestinal tract intact, without being hydrolyzed into absorbable fatty acids and glycerol.

69. (D) A smooth network that immobilizes liquid oil
The beta prime polymorph forms small, delicate, needle-like fat crystals that aggregate into a dense, three-dimensional network. This specific crystalline structure is highly effective at trapping and immobilizing liquid oil droplets within the margarine matrix. This prevents oil separation, ensuring an exceptionally smooth, plastic texture and superior product spreadability at refrigeration temperatures.

70. (B) Shears heated proteins into spherical, fat-like particles
Microparticulation is a mechanical and thermal process used to manufacture protein-based fat replacers. It involves heating whey proteins or egg whites to cause coagulation, while simultaneously applying high-shear forces. This dual action breaks up the proteins into tiny, uniform spherical particles that mimic the size and physical mouthfeel of natural fat droplets.

71. (C) Water-in-oil (W/O) emulsion
The hydrophilic-lipophilic balance value dictates the affinity and function of a surfactant. Emulsifiers with low HLB values between three and six are highly lipophilic, meaning they dissolve preferentially in oils. Consequently, these surfactants are utilized to stabilize water-in-oil emulsions, such as butter and margarine, where water droplets must be dispersed within continuous oil.

72. (D) Milk proteins
Milk proteins, particularly caseins and whey proteins, act as primary foaming agents in frozen dairy desserts. During whipping and freezing, these proteins rapidly migrate to the air-water interface, lowering surface tension. They form a cohesive, elastic viscoelastic film around the incorporated air bubbles, providing the essential structural stability required to maintain the desired overrun.

73. (A) Polysaccharides
Stabilizers used in frozen dairy formulations are highly hydrophilic macromolecules classified chemically as polysaccharides. Derived from plants, seaweeds, or microbes, common stabilizers include sodium alginate, guar gum, locust bean gum, and carrageenan. These polymers act by binding large amounts of free water and increasing viscosity, preventing recrystallization and ice crystal growth during storage.

74. (B) Minimum weight per unit volume
FSSAI regulatory guidelines for standard ice cream mandate strict minimum thresholds for nutritional and physical parameters. In addition to specifying minimum fat and total solids content, the regulations enforce a strict minimum weight per unit volume. This prevents manufacturers from incorporating excessive air, or overrun, which would otherwise dilute the overall nutritive value.

75. (B) Formulating with excess lactose from whey powder
The sandiness defect in ice cream is caused by the slow crystallization of excess lactose during frozen storage. Lactose has low solubility at freezing temperatures, and if the lactose concentration exceeds critical limits due to excessive whey powder addition, it precipitates as large, sharp alpha-hydrate crystals, imparting a distinct gritty, sandy mouthfeel to the consumer.

76. (A) I, II and III
Emulsifiers act during aging by displacing protective milk proteins from the fat globule surface, which encourages partial coalescence during freezing. Polysorbate eighty has a high HLB value and actively promotes this required coalescence. Stabilizers function primarily by binding water to increase aqueous phase viscosity, while locust bean gum and gelatin have different heat requirements.

77. (A) II → IV → III → I
The HLB values range from highly lipophilic to highly hydrophilic. Mono- and diglycerides have very low HLB values between three and four. Sorbitan monostearate is slightly less lipophilic, followed by sodium stearoyl lactylate which has intermediate hydrophilicity. Polysorbate eighty possesses the highest HLB value of approximately fifteen, making this compound highly water-soluble.

78. (D) They promote partial coalescence of fat globules
Polysorbates are highly active surfactants used to optimize the fat structure in frozen desserts. During mix aging, they competitively displace milk proteins from the surface of fat globules. This reduction in steric hindrance allows the

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globules to touch and form controlled, three-dimensional aggregates, or partial coalescence, which stabilizes air cells during dynamic freezing.

79. (C) The affinity of a surfactant for oil versus water
The Hydrophilic-Lipophilic Balance scale is an empirical numerical system ranging from one to twenty. It mathematically defines the relative proportions of hydrophilic and lipophilic groups within a surfactant molecule. This value directly indicates whether an emulsifier has a higher affinity for water or oil, which dictates its selection for stabilizing specific types of emulsions.

80. (B) A heavy, gummy, or chewy body defect
Hydrocolloid stabilizers increase viscosity by binding free water molecules in the mix. When added in excessive amounts, they bind water too tightly, creating a dense, highly viscous gel matrix in the unfrozen phase. This high viscosity manifests in the finished frozen dessert as an undesirable heavy, gummy, or chewy physical body defect.

81. (D) Viscosity and high solids protect microorganisms from heat
Ice cream mixes contain high levels of total solids, including milk fat, proteins, and added sugars. This complex, highly viscous composition acts as a protective physical shield for microbial cells, increasing their thermal resistance. Consequently, higher temperatures and longer holding times are legally mandated to guarantee complete destruction of pathogens like Listeria monocytogenes.

82. (A) It significantly decreases the viscosity of the mix.
Homogenization forces the liquid mix through a restricted orifice under high pressure, breaking fat globules down to under two microns. This dramatic decrease in size exponentially increases the surface area of the fat phase. This newly exposed surface binds more milk proteins and stabilizers, which significantly increases, rather than decreases, the overall viscosity of the mix.

83. (C) Reduce the amount of added emulsifier
Churning out during dynamic freezing indicates that too much liquid fat has been released from globules due to excessive partial coalescence. This is driven by high concentrations of emulsifiers, which aggressively displace protective proteins from the fat surface. Reducing the emulsifier concentration increases protein coverage, stabilizing the globules against high mechanical shear inside the freezer.

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84. (A) Competitive adsorption and displacement by added emulsifiers
During the cooling and aging of ice cream mix, added small-molecule emulsifiers like mono- and diglycerides or polysorbates migrate to the fat interface. Because these surfactants are highly surface-active, they lower interfacial tension more effectively than milk proteins. Consequently, they competitively displace and desorb proteins from the fat surface, facilitating subsequent partial fat coalescence.

85. (A) 0 to 4 °C for 4 to 24 hours
Standard commercial ice cream mixes are aged at refrigeration temperatures between zero and four degrees Celsius for a period of four to twenty-four hours. This specific duration and low temperature are required to ensure complete crystallization of the fat phase, allow complete hydration of stabilizers, and facilitate the competitive displacement of proteins by emulsifiers.

86. (B) Substantial Maillard browning
The aging process occurs at refrigeration temperatures between zero and four degrees Celsius. At these low temperatures, physical changes such as stabilizer hydration, liquid fat crystallization, and emulsifier-driven protein desorption occur. However, Maillard browning is a heat-dependent chemical reaction that is completely inactive during cold storage, requiring high temperatures to proceed at significant rates.

87. (C) A smoother texture and better emulsion stability
Homogenizing an ice cream mix at optimal high pressure around two thousand pounds per square inch efficiently reduces fat globule size. This size reduction prevents gravity separation during storage, improving overall emulsion stability. Additionally, the smaller globules facilitate the formation of a finer fat-crystal network, resulting in a significantly smoother texture in the finished dessert.

88. (D) Fat globule agglomeration via penetrating crystals
Partial coalescence is a unique agglomeration process where fat globules collide inside the dynamic freezer under mechanical shear. The internal solid fat crystals from one globule pierce the membrane of another, binding them together. This creates an open, three-dimensional network of fat that surrounds and stabilizes the incorporated air cells, preventing foam collapse.

89. (A) Aging: Crystallization and protein desorption
The aging step for ice cream mix is designed to achieve specific physical changes. Storing the mix at cold temperatures allows the liquid fat core within the globules to undergo complete crystallization. Simultaneously, added emulsifiers migrate to the lipid-water interface, driving competitive protein desorption which prepares the globules for subsequent partial fat coalescence.

90. (B) Reduced overrun and weak body structure
Bypassing the mix aging step prevents fat crystallization and stabilizer hydration from reaching completion. Consequently, during dynamic freezing, the liquid fat globules lack the structural integrity to undergo controlled partial coalescence, leading to weak air-cell stabilization. This results in reduced overrun capacity and a weak, watery body structure in the finished frozen dessert.

91. (B) -2.5 °C
An ice cream mix is a highly concentrated aqueous solution containing dissolved sugars, mineral salts, and proteins. These dissolved solutes cause a freezing point depression compared to pure water. Consequently, rather than freezing at zero degrees Celsius, a typical standard formulation exhibits an initial freezing point of approximately minus two point five degrees Celsius.

92. (A) The freezing point of the remaining solution rises during freezing
As water is frozen out of an ice cream mix as pure ice crystals, the solutes remain dissolved in the decreasing volume of liquid water. This concentration increase makes the remaining solution progressively more concentrated. Consequently, according to colligative properties, the freezing point of this unfrozen phase continually drops, rather than rising, during freezing.

93. (A) Both A and R are true and R is the correct explanation of A.
The sensory texture of ice cream is heavily dependent on ice crystal size. Rapid heat removal in a continuous scraped-surface heat exchanger supercools the mix, driving exceptionally high crystal nucleation rates. This rapid process generates millions of micro-crystals rather than allowing existing crystals to grow large, yielding an extremely smooth texture in the finished product.

94. (D) Scrape ice from walls to enhance heat transfer
During dynamic freezing, ice crystals rapidly form on the internal cylinder walls of the heat exchanger, which are directly cooled by liquid refrigerant. If left undisturbed, this ice layer acts as a thermal insulator, severely impeding heat transfer. Scraper blades continually shave off this ice layer, facilitating rapid heat exchange and maintaining efficient cooling.

95. (C) $\left[\frac{\text{Weight of mix} - \text{Weight of ice cream}}{\text{Weight of ice cream}}\right] \times 100$
The weight-based overrun formula measures the percentage volume increase of ice cream due to air incorporation. Because air has negligible mass, a given volume of ice cream weighs less than the same volume of liquid mix. The weight of the ice cream is subtracted from the mix weight, divided by the ice cream weight, and multiplied by one hundred.

96. (B) Atmospheric pressure outside the plant
Ice crystal size is governed by internal processing and storage factors, including freezing speed, residence times in the dynamic freezer, cold tunnel hardening rates, and temperature fluctuations during distribution. Atmospheric pressure outside the processing facility has no physical impact on these closed thermodynamic systems, as they operate under highly controlled internal pressures.

97. (D) Freezing remaining free water without agitation
Dynamic freezing inside the scraped-surface heat exchanger freezes only about half of the water. The remaining liquid phase must be frozen during static hardening in a cold storage tunnel.

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Because this step occurs without mechanical agitation, it focuses on freezing the remaining water rapidly to lock the established ice crystal structure and prevent its growth.

98. (A) Temperature cycles causing ice crystal accretion
Heat shock is a physical defect caused by temperature fluctuations during ice cream storage and transport. When temperature rises, small ice crystals melt into the surrounding serum phase. When temperature drops again, this water refreezes onto the remaining crystals rather than forming new ones, leading to crystal accretion and a coarse, icy texture.

99. (A) P-2, Q-3, R-1, S-4
Freezing parameters correspond to specific physical states of the ice cream mix. The liquid mix enters the freezer at approximately four degrees Celsius and is drawn dynamically at minus five to minus seven degrees Celsius, with half of the water frozen. Hardening is then conducted at temperatures between minus thirty and minus forty degrees Celsius.

100. (A) Smaller ice crystal size and better shape retention
Stiff extrusion involves drawing the frozen dessert from the continuous freezer at exceptionally low temperatures. This low draw temperature indicates that a higher percentage of the water has been frozen rapidly under high shear. This process ensures the formation of very small ice crystals and superior structural shape retention in the packaged product during subsequent hardening.

101. (D) Served directly without hardening at -5 °C
Soft-serve ice cream bypasses the static hardening stage used in packaged ice cream production. Instead, the product is dispensed directly from the dynamic continuous freezer at consumption temperatures around minus five degrees Celsius. This omission of hardening maintains a high proportion of liquid water and a soft, smooth, flowing consistency favored for immediate consumption.

102. (B) Removing all stabilizers to lower the glycemic index
Diabetic formulations substitute glycemic sugars with intense sweeteners and bulking agents like polydextrose to maintain dry mass and freezing point depression. However, removing all stabilizers is incorrect because hydrocolloids do not impact glycemic index significantly. Stabilizers remain essential for binding water and preventing rapid ice crystal growth to preserve acceptable physical texture during storage.

103. (C) Adding microparticulated proteins and hydrocolloids
Reducing fat in ice cream diminishes creamy mouthfeel, viscosity, and lubricating properties. To counteract these defects, formulators incorporate microparticulated whey proteins and hydrocolloid stabilizers. The tiny protein particles mimic the size and physical behavior of fat globules, while the hydrocolloids bind water to restore viscosity, delivering a rich texture without adding fat calories.

104. (D) Protein curdling
Ice cream mixes contain abundant casein micelles stabilized by negative electrical charges at near-neutral pH. Highly acidic fruit pulps introduce excess hydrogen ions, lowering the pH of the unbuffered mix close to the casein isoelectric point of 4.6. This neutralization of charge causes the proteins to precipitate, leading to undesirable curdling and phase separation.

105. (B) Mix formulation → Pasteurization → Dynamic Freezing → Fruit addition via fruit feeder → Hardening
Commercial ice cream manufacture requires a precise sequence to protect product texture and hygiene. The base mix is formulated and pasteurized to eliminate pathogens, then undergoes dynamic freezing. Solid fruit pieces cannot pass through the freezer dasher without damage; thus, they are injected into the frozen stream via a fruit feeder before final static hardening.

106. (B) Replacement of all water with concentrated liquid milk fat
Dietetic ice creams reduce caloric density through fat substitution, sugar replacement, and increasing overrun. Replacing water with concentrated liquid milk fat is completely incorrect for calorie reduction, as lipids deliver nine kilocalories per gram, representing the most energy-dense constituent. Water, conversely, has zero caloric value and is maximized to lower the total energy content.

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107. (B) Greater freezing point depression per gram
Sorbitol is a sugar alcohol with a molecular weight of approximately one hundred and eighty-two grams per mole, which is much lower than sucrose at three hundred and forty-two. Colligative properties dictate that freezing point depression is determined by molecular concentration. Consequently, sorbitol exerts a significantly greater freezing point depression per gram than sucrose.

108. (A) Replacement of milk fat with vegetable fat
Mellorine is a frozen dessert that is physically identical to standard ice cream in texture, processing, and milk solids-not-fat content. However, the regulatory definition relies on the complete or partial substitution of milk fat with cheaper vegetable fats or oils. This substitution significantly reduces production costs while maintaining similar physical and overall organoleptic properties.

109. (C) Gelato: Low overrun and dense texture
Gelato is a traditional Italian frozen dessert characterized by a low overrun of around twenty to thirty percent, compared to over eighty percent in standard ice cream. This low air incorporation, combined with a slightly warmer serving temperature and less fat, creates a highly dense, rich, and intensely flavored overall physical texture.

110. (D) Drastic freezing point lowering, causing softness
Fruit syrups contain exceptionally high concentrations of monosaccharides like fructose and glucose. Because these small sugars have low molecular weights, they depress the freezing point of the mix far more than sucrose. Excess syrup addition depresses the freezing point drastically, preventing water from freezing at standard temperatures and yielding an unacceptably soft, melt-prone product.

111. (A) II → I → III → IV
The traditional manufacture of authentic Kulfi begins with the slow, continuous concentration of milk in an open pan to reduce its volume by half. Sugar, flavorings, and nuts are then blended into the hot, thickened mass. This concentrated mixture is cooled, poured into metallic cone molds, sealed, and statically frozen in an ice-salt freezing mixture.

112. (B) It relies on continuous agitation during freezing to achieve high overrun.
Traditional Kulfi differs from standard ice cream because it does not undergo any dynamic whipping or air incorporation during the freezing step. Instead, the concentrated, sweetened milk formulation is poured into sealed molds and frozen statically. This complete lack of mechanical agitation yields zero overrun, resulting in the characteristic dense, compact, and icy physical structure.

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113. (D) Incorporate pre-caramelized condensed milk
Traditional Kulfi flavor is characterized by rich cooked and caramelized notes generated by hours of boiling. In a rapid, high-throughput continuous production line, replicating this prolonged thermal treatment is inefficient. To simulate this authentic profile, modern manufacturers blend pre-caramelized condensed milk or specific caramel flavor compounds directly into the standardized mix prior to freezing.

114. (A) Lactose and ice crystallization from unagitated freezing
Malai-ka-baraf is frozen using traditional, unagitated static methods, which dramatically slows the rate of heat extraction. Because there is no mechanical shearing to break up growing crystals, both ice and lactose molecules aggregate into large, crystalline structures. This slow, unagitated crystallization process yields large crystals that impart the characteristic sandy, grainy, and crunchy mouthfeel.

115. (C) 35-40% Total Solids
Authentic Kulfi mix is prepared by boiling whole milk in an open pan until it has concentrated to nearly half of its original volume. This extensive dehydration, combined with the addition of sugar and solid ingredients like nuts, elevates the total solids concentration significantly, typically reaching approximately 35-40% total solids prior to freezing.

116. (C) Scraped-surface heat exchangers
Traditional kulfi preparation involves slow boiling of milk in open, shallow, heavy-bottomed pans. This thermal process relies on natural evaporative concentration and manual stirring to prevent scorching. Earthen or metallic molds are used to freeze the sweetened concentrate. Advanced continuous industrial equipment like

scraped-surface heat exchangers is not part of the authentic, traditional manufacturing method.

117. (A) Zero overrun and higher density
Traditional kulfi is prepared without whipping or air incorporation during the freezing process. This lack of aeration results in a product with virtually zero overrun, creating a dense, compact, and slow-melting structure. In contrast, standard western ice cream undergoes mechanical whipping during freezing, which incorporates significant amounts of air, resulting in high overrun and a lighter body.

118. (D) The clotted cream layer formed on the surface of slowly heated milk
Slow heating of whole milk in open pans allows fat globules to rise and cluster at the surface. As water evaporates from the surface, a skin forms, composed of coagulated proteins and concentrated milk lipids. This rich, clotted cream layer, known as malai, is manually skimmed off and serves as a major ingredient in traditional desserts.

119. (B) Malai-ka-baraf : Brine or ice-salt mixture
Historical freezing techniques for indigenous Indian frozen treats like malai-ka-baraf utilized a cooling mixture of ice and salt or brine. This combination depresses the freezing point of water, allowing temperatures to drop below zero degrees Celsius. This chemical reaction creates an effective, low-temperature medium capable of freezing sweetened, concentrated milk mixtures in primitive, sealed containers.

120. (C) High variability in product quality and poor energy efficiency
Open-pan concentration relies heavily on manual labor and non-standardized thermal exposure, leading to significant fluctuations in moisture loss, color, and flavor. Additionally, heating large volumes of milk in open vessels causes immense thermal energy loss to the surroundings. This makes the traditional process highly energy-inefficient and difficult to scale up for consistent, industrial-level commercial manufacturing.

121. (C) -12 °C to -15 °C
Conventional continuous freezers typically discharge ice cream at temperatures around minus five degrees Celsius. Low-temperature extrusion technology applies intensive shear and additional cooling to further reduce the temperature of the semi-frozen matrix down to minus twelve to minus fifteen degrees Celsius. This significant temperature reduction freeze-concentrates more water, creating a highly stable and structured final product.

122. (A) Complete elimination of the subsequent static hardening step
Low-temperature extrusion significantly reduces the size of ice crystals and fat agglomerates, which enhances creaminess and melting resistance. However, because the product exits the extruder at minus twelve to minus fifteen degrees Celsius, it still contains unfrozen water. A subsequent static hardening step remains necessary to lower the core temperature to standard storage levels below minus eighteen.

123. (A) Both (A) and (R) are true and (R) is the correct explanation of (A).
Frozen storage of dairy desserts poses a threat to probiotic viability due to physical and chemical factors. Mechanical shearing during freezing damages bacterial membranes, while ice crystallization and high sugar concentration generate high osmotic pressure, causing cellular dehydration. These combined environmental stresses injure the microbial cells, directly resulting in a gradual decline in viable counts over storage.

124. (B) Ultra-rapid freezing and formation of microscopic ice crystals
Contact with liquid nitrogen at extremely low temperatures induces a state of ultra-rapid freezing in the mix. This rapid heat transfer maximizes the rate of ice nucleation while minimizing the time available for crystal growth. Consequently, water molecules form a vast number of microscopic ice crystals, resulting in an exceptionally smooth texture in the final frozen dessert.

125. (A) Preventing oxidative rancidity and off-flavors
Omega-3 fatty acids possess multiple double bonds, making them highly susceptible to autoxidation. When incorporated into ice cream, exposure to incorporated air and light during processing accelerates the formation of primary and secondary oxidation products. This reaction yields highly undesirable fishy, metallic off-flavors, presenting the primary technological hurdle in formulating functional, shelf-stable enriched frozen dairy products.

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126. (C) Sodium chloride (in high concentrations)
Cryoprotectants like trehalose, polydextrose, and antifreeze proteins protect ice cream structure by depressing the freezing point and inhibiting recrystallization. Although sodium chloride depresses the freezing point, high concentrations are unsuitable for use as a cryoprotectant in frozen dairy desserts. Excess salt generates severe salty off-flavors, destabilizes proteins, and destroys the delicate sensory profile required for palatable sweet desserts.

127. (D) Much higher shear rates and longer residence times
Single-screw low-temperature extruders operate under high pressure to force highly viscous, semi-frozen ice cream through a cooled barrel. This mechanical configuration exposes the product to much higher shear rates and longer residence times than conventional scraped-surface freezers. These processing conditions are necessary to efficiently break down ice crystals and fat globules at temperatures below minus ten degrees.

128. (C) Adsoring directly to ice crystal surfaces to inhibit further growth
Antifreeze proteins function through a non-colligative mechanism by binding directly to specific planes of growing ice crystals. This adsorption creates a thermal hysteresis effect, preventing further water molecules from joining the crystal lattice. Consequently, these specialized proteins restrict ice crystal growth and recrystallization during storage fluctuations, preserving the original smooth texture of frozen dairy matrices.

129. (B) P-4, Q-2, R-3, S-1
Advanced freezing technologies rely on distinct thermodynamic and mechanical principles. Liquid nitrogen utilizes rapid vaporization at minus one hundred ninety-six degrees Celsius. High-pressure freezing shifts thermodynamic phase diagrams to prevent crystallization. Low-temperature extrusion applies intense shear to highly viscous matrices at sub-zero temperatures. Ultrasound-assisted freezing utilizes high-frequency acoustic waves to induce micro-cavitation, promoting rapid ice nucleation.

130. (D) Negative sensory impacts like a gritty or sandy texture
Microencapsulation protects probiotic cells from physical and chemical stresses, ensuring higher viability during freezing and storage. However, the protective capsule materials often have a particle size exceeding twenty microns. When added to ice cream, these large capsules are easily detected by the tongue, imparting an undesirable gritty, sandy, or powdery texture that negatively impacts overall sensory quality.

131. (A) Heat stability and protein integrity
The alcohol test is a rapid platform method used to evaluate the thermal stability of incoming raw milk. Mixing equal volumes of milk and ethanol induces protein precipitation if the milk has developed acidity or has an unfavorable salt balance. This rapid screening identifies milk batches that cannot withstand the high temperatures used during concentration, sterilization, or drying.

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132. (C) Milk with high titratable acidity is preferred for evaporation.
Raw milk selected for evaporation must have low titratable acidity and high protein stability to survive the thermal stresses of concentration. Milk with high acidity contains elevated levels of free hydrogen ions, which destabilize casein micelles and cause premature coagulation during thermal processing. Therefore, low-acidity milk is strictly preferred, while highly acidic milk is rejected for concentration.

133. (A) The addition of alkali to mask developed acidity
The presence of neutralizers, such as sodium bicarbonate or sodium hydroxide, indicates illegal adulteration of raw milk. Producers add these alkaline compounds to neutralize lactic acid produced by bacterial fermentation, artificially lowering the titratable acidity. This chemical manipulation masks poor hygienic quality, allowing sour milk to falsely pass standard acidity checks at processing facilities.

134. (D) Susceptibility to lipolysis and proteolysis, yielding off-flavors
Milk with high somatic cell counts contains elevated levels of endogenous heat-stable enzymes, particularly plasmin and lipases, associated with mastitis. These enzymes survive standard pasteurization and concentrate during evaporation. Throughout the storage of the resulting milk powder, they actively hydrolyze proteins and lipids, releasing bitter peptides

remedy. The phosphate ions chemically bind with the excess calcium, reducing the concentration of free ionic calcium in the serum. This chelation restores the salt balance, stabilizes the casein micelles, and prevents premature thermal coagulation.

154. (A) Complex formation between beta-lactoglobulin and kappa-casein
Forewarming milk at ninety to ninety-five degrees Celsius denatures whey proteins, specifically beta-lactoglobulin. These denatured proteins interact with kappa-casein on the surface of casein micelles through disulfide bonding, forming a protective complex. This structural modification alters the micellar surface charge and sterically hinders aggregation, significantly increasing the heat stability of the concentrated milk.

155. (B) A pronounced maximum stability at pH 6.7 and a minimum at pH 6.9
Type A milk, which represents the majority of bovine milk supplies, exhibits a highly characteristic heat coagulation time-pH profile. This profile features a sharp maximum in thermal stability near pH 6.7, followed by a pronounced minimum near pH 6.9. Beyond this minimum, stability increases again as the pH becomes more alkaline, reflecting complex protein charge interactions.

156. (B) Forewarming treatments
The heat stability of milk is negatively affected by factors that destabilize casein micelles, such as high calcium ion activity, increased acidity, and the presence of colostrum. Conversely, controlled forewarming treatments enhance heat stability. This pre-heating step denatures whey proteins and promotes their association with kappa-casein, protecting the micelles from thermal aggregation during subsequent processing.

157. (A) Longer times to coagulate at the same temperature
Unconcentrated fluid milk possesses a lower density of proteins and mineral salts compared to concentrated milk. This lower concentration of reactants increases the distance between casein micelles, reducing the frequency of collisions. Consequently, unconcentrated milk requires significantly longer heating times to undergo thermal coagulation at a given temperature, demonstrating higher relative stability than concentrated forms.

158. (C) The time needed to induce visible coagulation at a specific high temperature
Heat coagulation time is a key scientific parameter used to quantify the thermal stability of milk systems. It measures the exact duration of exposure required to induce visible protein flocculation or gelation when a milk sample is heated at a specified elevated temperature. This test helps determine the suitability of milk for sterilization and concentration.

159. (D) Calcium : Destabilizing/Coagulating agent
Under the Sommer-Binney salt balance theory, ionic species in milk are categorized by their influence on casein micelle stability. Divalent cations, particularly calcium and magnesium, act as destabilizing agents that reduce micellar charge and promote thermal coagulation. Divalent anions, such as phosphate and citrate, act as stabilizing agents by binding these cations, preserving the suspension.

160. (C) Risk of sediment or sludge formation during storage
While adding stabilizing salts like phosphates improves the heat stability of concentrated milk during sterilization, excessive use carries technical disadvantages. Over time, these added salts can react with calcium to form insoluble calcium phosphate complexes. These minerals precipitate out of the liquid phase, forming an undesirable sediment or gritty sludge at the bottom of the container.

161. (B) Lowering water activity (a_w) via high sucrose concentration
Sweetened condensed milk is not sterilized after packaging; instead, its preservation depends on osmotic pressure. The addition of high concentrations of sucrose increases the total solids content, which significantly lowers the water activity of the liquid. This reduced water availability dehydrates microbial cells and inhibits the growth of bacteria, yeasts, and molds under normal conditions.

162. (D) It aims to force the formation of a few very large lactose crystals.
The manufacturing process of sweetened condensed milk involves rapid cooling and adding finely ground lactose seed crystals. This seeding

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144. (C) Re-use of latent heat to increase thermal efficiency (steam economy)
Multiple-effect evaporators achieve high thermal efficiency by operating successive effects at progressively lower pressures and boiling temperatures. This pressure gradient allows the vapor generated in one effect to serve as the heating steam for the subsequent effect. Re-using the latent heat of vaporization across multiple stages significantly increases the overall steam economy of the system.

145. (B) Entraining and compressing low-pressure vapor using a high-pressure steam jet
Thermal vapor recompression utilizes a steam ejector to improve energy efficiency during concentration. High-pressure motive steam is injected through a nozzle, creating a vacuum that entrains a portion of the low-pressure exhaust vapor from the separator. The mixing of these streams compresses the low-pressure vapor, raising its temperature so it can be re-used as heating steam.

146. (D) Complete sterilization of the milk
Vacuum evaporation concentrates milk by boiling off water under reduced pressure, which lowers the boiling temperature and minimizes thermal damage to proteins and sugars. While this process reduces product volume for transport and prepares the feed for spray drying, the operating temperatures are insufficient to achieve complete sterilization, which requires higher, specialized thermal treatments.

147. (A) Operation at smaller temperature differences (ΔT)
Falling film evaporators operate with a gravity-assisted downward flow, which maintains a thin liquid layer on the tube surfaces even at high viscosities. This design enables efficient heat transfer at lower temperature differences between the heating steam and the boiling milk. This allows for gentler evaporation, lower residence times, and reduced thermal degradation of milk constituents.

148. (C) Kilograms of water evaporated per kilogram of steam consumed
Steam economy is a fundamental performance metric used to evaluate the thermodynamic efficiency of an evaporator system. It is defined as the mass of water evaporated from the product divided by the mass of motive steam supplied to the system. Higher steam economy values indicate more efficient energy utilization, typically achieved by incorporating multiple effects or vapor recompression.

149. (A) Calandria : Transfers heat from steam to milk across tubes
The calandria is the core heat exchanger of an evaporator, consisting of a bundle of vertical tubes enclosed in a steam shell. Steam condenses on the outer surfaces of the tubes, transferring its latent heat to the milk flowing along the inner surfaces. This continuous heat transfer drives the boiling and vaporization of water from the milk.

150. (D) Boiling temperature rises, increasing thermal damage and denaturation risk
Operating an evaporator at an insufficiently low vacuum means the absolute pressure inside the chamber remains high. According to thermodynamic principles, higher operating pressure increases the boiling temperature of the milk. This elevated thermal exposure accelerates chemical degradation, such as protein denaturation and Maillard browning, compromising the overall quality of the concentrated dairy product.

151. (B) 10 to 20 minutes
The heat coagulation time of normal bovine milk at one hundred forty degrees Celsius typically ranges between ten and twenty minutes. This measurement reflects the inherent stability of the casein micelles under extreme thermal stress. The exact time is highly dependent on factors such as pH, ionic salt balance, whey protein concentration, and prior heat treatments.

152. (C) Calcium and magnesium stabilize casein micelles against coagulation.
The salt balance theory states that milk heat stability is governed by the equilibrium between divalent cations and anions. Multivalent calcium and magnesium ions act as destabilizing agents by neutralizing the negative charge on casein micelles, promoting aggregation. Conversely, citrate and phosphate ions act as stabilizers by chelating these divalent cations, thereby maintaining micellar dispersion.

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153. (D) Disodium phosphate salt
When concentrated milk exhibits poor heat stability due to an excess of free calcium ions, adding disodium phosphate is an effective

172. (B) The product is preserved by high sugar content rather than heat.
Evaporated milk is an unsweetened concentrated milk product that contains no added sugar. Consequently, its preservation depends entirely on heat sterilization, such as in-container retorting, to destroy all vegetative cells and bacterial spores. Standard processing steps include intensive homogenization to prevent fat separation and the addition of stabilizing salts to prevent protein coagulation during thermal treatment.

173. (A) Age gelation
Age gelation is a physical defect characterized by a gradual, irreversible increase in the viscosity of UHT sterilized concentrated milk during storage, eventually forming a continuous gel network. This phenomenon is caused by the aggregation of casein micelles, often initiated by the release of kappa-casein or residual activity of heat-stable proteases that survive the sterilization process.

174. (C) Development of characteristic brown color and cooked flavor
The intense thermal energy applied during the retorting of evaporated milk initiates the Maillard browning reaction. This non-enzymatic reaction occurs between the carbonyl groups of lactose and the amino groups of milk proteins, particularly lysine. This reaction generates melanoidin pigments and volatile flavor compounds, imparting the characteristic cooked flavor and caramel-like brown color to the product.

175. (D) Both Clostridium botulinum and resistant thermophilic spores
The F-value established for the commercial sterilization of evaporated milk is calculated to ensure safety and stability. The heat treatment must guarantee the destruction of Clostridium botulinum spores to ensure public health safety, as well as the inactivation of highly heat-resistant thermophilic spores like Bacillus stearothermophilus to prevent spoilage during transport and storage at ambient temperatures.

176. (C) Complete enzymatic hydrolysis of all casein micelles
To prevent age gelation in UHT concentrated milk, technologists can use strategies such as adding specific polyphosphates, applying severe forewarming treatments to denature whey proteins, or maintaining low-temperature storage. However, complete enzymatic hydrolysis of casein micelles is not an appropriate strategy, as it would destroy the structural integrity of the milk proteins, yielding a watery product.

177. (B) Higher retention of vitamins and a whiter product color
UHT sterilization subjects concentrated milk to high temperatures for a short duration. This rapid process minimizes the thermal destruction of heat-labile vitamins and limits the Maillard reaction. Consequently, UHT-processed concentrated milk retains more nutrients and maintains a whiter color compared to retorted evaporated milk, which undergoes prolonged heating in the container, leading to significant darkening.

178. (D) Upward physical migration of fat globules during storage
Creaming is a physical defect in evaporated milk that occurs when fat globules rise to the surface during storage. This upward migration is driven by the density difference between the lipid phase and the aqueous serum, as described by Stokes' law. Proper homogenization is required to reduce fat globule size, slowing this separation and maintaining a uniform emulsion.

179. (A) In-container sterilization : 115-121 °C for 10-20 min
Unsweetened evaporated milk requires in-container retort sterilization to achieve commercial sterility. The typical thermal profile for this process involves heating the filled, sealed cans at one hundred fifteen to one hundred twenty-one degrees Celsius for ten to twenty minutes. This severe heat treatment is necessary to destroy heat-resistant bacterial spores, ensuring a long shelf life.

180. (C) Susceptibility to age gelation and enzyme reactivation over storage
Although UHT concentrated milk possesses superior initial sensory quality and nutritional retention, it has a significant commercial disadvantage during storage. The short thermal exposure may fail to completely inactivate native proteases or may allow enzyme reactivation over time. This residual enzymatic activity, combined with destabilized proteins, makes UHT concentrated milk highly susceptible to age gelation and thinning.

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step provides a large number of nuclei to promote rapid, controlled crystallization. The goal is to produce millions of microscopic crystals under ten microns in size, preventing the formation of large crystals that cause a gritty texture.

163. (C) $60 - 64.5\%$
The sugar ratio represents the percentage of sucrose dissolved in the aqueous phase of sweetened condensed milk. To ensure complete microbiological preservation and prevent the growth of osmophilic yeasts and molds, this ratio must be maintained between sixty and sixty-four and a half percent. Ratios below this range compromise shelf life, while higher ratios cause sucrose crystallization.

164. (C) Casein micelle interactions and residual plasmin activity
Age gelation in sweetened condensed milk is a physical defect that causes a progressive increase in viscosity, leading to gel formation. This phenomenon is driven by slow, non-enzymatic interactions between casein micelles and whey proteins, as well as residual activity of heat-stable native proteases like plasmin. These factors gradually build a three-dimensional protein network during storage.

165. (A) $\left(\frac{\%\text{Sucrose}}{\%\text{Sucrose} + \%\text{Water}}\right) \times 100$
The sugar ratio of sweetened condensed milk measures the concentration of sucrose within the liquid phase. This value is mathematically calculated by dividing the percentage of sucrose by the sum of the sucrose and water percentages, then multiplying by one hundred. Maintaining this ratio within strict limits is critical to ensuring the microbiological stability of the product.

166. (D) Syneresis due to rennet action
Sweetened condensed milk is susceptible to defects such as lactose sandiness, viscosity-related age gelation, and button formation from mold growth. However, syneresis due to rennet action is not a standard defect of this product. The intense heating and high osmotic pressure applied during processing denature and inactivate coagulating enzymes, preventing enzymatic curd formation and subsequent syneresis.

167. (B) No severe in-container thermal sterilization due to its osmotic pressure
Unlike evaporated milk, which must undergo severe in-container retort sterilization to ensure commercial sterility, sweetened condensed milk does not require post-packaging heat treatment. The high concentration of added sucrose exerts immense osmotic pressure, which naturally inhibits microbial growth. This allows the product to remain stable at ambient temperatures without undergoing intensive thermal sterilization.

168. (C) Lactose crystals exceeding 15-20 μm in size
Sandiness is a textural defect in sweetened condensed milk that occurs when lactose crystals grow too large during storage. If these crystals exceed fifteen to twenty microns in size, they can be detected by the sensory receptors in the mouth, creating a gritty or sandy mouthfeel. Proper seeding and cooling during manufacture prevent this defect.

169. (D) Buttons : Molds forming firm, discolored coagula
The defect known as buttons in sweetened condensed milk is characterized by the formation of small, firm, discolored coagula on the surface of the product. This defect is caused by the growth of specialized, heat-resistant molds, such as Aspergillus species, which produce proteolytic enzymes. These enzymes coagulate the proteins locally, creating distinct button-like structures.

170. (A) Avoidance of complex thermal sterilization steps
The primary technological advantage of manufacturing sweetened condensed milk over evaporated milk is the avoidance of intensive, in-container thermal sterilization. Because preservation relies on high osmotic pressure from added sugar, the product does not undergo retorting. This simplifies the packaging line, reduces energy consumption, and eliminates the risk of thermal coagulation during post-packaging sterilization.

171. (B) 7.5%
Codex Alimentarius and international standards specify minimum composition requirements for evaporated milk to ensure product identity and quality. For standard unsweetened evaporated milk, the regulations require a minimum milk fat content of seven and a half percent by weight. This fat level, combined with total milk solids requirements, ensures the characteristic creamy body and nutritional profile.

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metal drums. This prolonged heat treatment accelerates the Maillard reaction between lactose and milk proteins. This results in a high degree of browning, scorched particles, and a distinct caramelized or cooked off-flavor.

191. (B) $3.0 - 4.0\%$
International and national food safety standards specify that the maximum permissible moisture content for skimmed milk powder should be between three and four percent by weight. Keeping moisture within this strict range is essential to prevent physical caking, minimize the Maillard browning reaction, and inhibit microbial growth, thereby ensuring a long shelf life during storage.

192. (C) Intensive homogenization prior to drying eliminates all free fat.
While intensive homogenization of concentrated milk prior to drying significantly reduces free fat, it cannot completely eliminate it. Some fat is always exposed on the particle surfaces during atomization and drying, which impairs flowability and increases susceptibility to oxidation. Therefore, stating that homogenization eliminates all free fat is chemically incorrect, as a small fraction always remains.

193. (B) Excessive heat treatment during evaporation or drying
An elevated insolubility index in skimmed milk powder indicates that a portion of the proteins has become insoluble in water. This defect is primarily caused by excessive heat exposure during pre-heating, evaporation, or drying. High temperatures denature whey proteins and destabilize casein micelles, causing them to form insoluble aggregates that fail to disperse during reconstitution.

194. (D) Reduced bulk density and increased oxidation susceptibility
High levels of occluded air inside spray-dried powder particles create internal vacuoles that increase the overall volume of the powder. This directly reduces the bulk density, requiring larger packaging materials. Furthermore, the oxygen trapped within these vacuoles accelerates lipid autoxidation in whole milk powder, leading to the rapid development of stale, oxidized off-flavors during storage.

195. (A) g / ml or kg / m^3
Bulk density is a physical property of powders defined as the mass of the powder divided by the total volume it occupies, including the space between particles. In dairy science and packaging engineering, this value is standardly expressed in units of grams per milliliter or kilograms per cubic meter, which are critical for calculating packaging and storage requirements.

196. (C) Nitrogen gas injection prior to atomization
Factors such as high feed solids, de-aeration of the concentrate, and lower drying temperatures increase bulk density by reducing internal air vacuoles in powder particles. Conversely, injecting nitrogen gas into the concentrated milk feed prior to atomization intentionally incorporates gas bubbles. This increases internal porosity and decreases the overall bulk density of the resulting powder.

197. (A) Susceptibility to oxidative rancidity due to milk fat presence
Whole milk powder contains high levels of milk lipids, which are absent in skimmed milk powder. This high fat content makes whole milk powder highly susceptible to oxidative rancidity during storage. Oxygen reacts with unsaturated fatty acids to form free radicals and aldehydes, which generate off-flavors, requiring the use of nitrogen flushing or oxygen scavengers in packaging.

198. (D) Measuring the volume of undissolved sediment after centrifugation
The insolubility index of milk powder is determined by reconstituting a standardized amount of powder in water under controlled mixing conditions. The reconstituted milk is then centrifuged in a graduated tube to separate the insoluble material. The volume of the resulting sediment, measured in milliliters, directly indicates the amount of denatured, insoluble protein in the sample.

199. (B) Caking : Moisture absorption leading to lactose crystallization
Caking is a physical defect in milk powder that occurs when the powder absorbs moisture from the environment. This moisture absorption plasticizes amorphous lactose, causing it to transition into a crystalline alpha-lactose monohydrate state. As lactose crystallizes, it forms solid bridges between adjacent powder

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181. (A) Rapid heat and mass transfer via massive surface area generation
Spray drying transforms liquid milk into dry powder by atomizing the feed into millions of micro-droplets inside a drying chamber. This atomization creates a massive surface area relative to the liquid volume, enabling extremely rapid heat and mass transfer. When these droplets contact hot air, water evaporates almost instantly, leaving behind dry, solid particles.

182. (D) Rotary atomizers are strictly incapable of handling highly viscous, concentrated milk.
Rotary atomizers use a rapidly spinning wheel or disc to fling liquid feed outward, shearing it into droplets. This design is highly versatile and capable of handling high feed rates and variations in viscosity, including highly concentrated milk. Therefore, stating that rotary atomizers cannot handle highly viscous feed is incorrect, as they are widely used for this purpose.

183. (B) Use high feed concentration and minimize entrained air
To maximize the bulk density of spray-dried milk powder, processors must minimize the air entrapped within the powder particles. Utilizing a high feed concentration increases the density of the individual droplets and reduces the volume of internal vacuoles. Additionally, preventing air entrainment during feed preparation and pumping ensures that the resulting powder particles are solid and compact.

184. (C) Direct contact with hot metal surfaces causes severe protein denaturation
Roller drying involves spreading a thin film of concentrated milk directly onto the outer surface of steam-heated rotating metal drums. This direct contact exposes the milk constituents to high temperatures for several seconds, causing severe thermal denaturation of the milk proteins, particularly casein and whey. Consequently, the resulting powder exhibits a significantly lower solubility index than spray-dried powder.

185. (D) Separate and recover fine powder particles from exhaust air
In a spray drying system, the exhaust air leaving the drying chamber carries fine powder particles that must be recovered. The cyclone separator uses centrifugal force to separate these solid particles from the air stream. The air enters tangentially, creating a vortex that flings the heavier powder particles against the walls, where they slide down for collection.

186. (A) Sublimation period
The drying of a milk droplet in a spray dryer involves several distinct physical phases, including a constant rate period where surface water evaporates rapidly, and a falling rate period where internal moisture diffusion limits drying. During this process, a solid crust forms on the particle surface. However, sublimation is not part of this process, as it is unique to freeze drying.

187. (B) Greater flexibility in handling varying feed rates and viscosities
Rotary atomizers offer significant operational advantages over pressure nozzle systems, particularly in terms of flexibility. Because they rely on centrifugal force rather than high pump pressure to atomize the liquid, they can easily accommodate changes in feed rate and milk viscosity without clogging or requiring nozzle replacements, making them highly reliable for continuous industrial operations.

188. (B) Internal moisture diffusion becomes the limiting factor for evaporation
The falling rate period occurs in the later stages of droplet drying when the surface is no longer fully saturated with free water. At this point, the rate of evaporation is limited by the speed at which internal moisture can diffuse through the forming solid crust to the particle surface. Consequently, the drying rate decreases significantly.

189. (A) Spray drying : Excellent solubility and flowability
Spray drying produces highly spherical, free-flowing milk powder particles with minimal thermal damage to milk proteins. This physical structure and protein integrity result in excellent solubility and reconstitution properties in water. In contrast, other drying methods like roller drying cause significant protein denaturation and produce irregular, flaky particles with lower overall solubility.

190. (C) High degree of Maillard browning and cooked flavor
The primary quality disadvantage of roller drying compared to spray drying is the intense thermal exposure of the milk film on the hot

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and free fatty acids that generate severe soapy, rancid off-flavors.

135. (B) Temperature check → Organoleptic evaluation → Alcohol test → Titratable Acidity
Upon arrival of milk tankers, the temperature is recorded immediately to verify cold chain compliance, followed by organoleptic evaluation to detect abnormal odors or appearance. Next, the rapid alcohol test is performed to screen for protein stability before conducting the more precise and time-consuming titratable acidity titration. This systematic workflow ensures efficient and logical quality control.

136. (C) Gerber test
The Methylene Blue Reduction Test, Resazurin test, and Standard Plate Count are standard microbiological assays used to evaluate the hygienic quality and bacterial load of raw milk. In contrast, the Gerber test is a quantitative chemical assay designed solely to measure the percentage of fat in milk using sulfuric acid and amyl alcohol, without assessing sanitary conditions.

137. (D) Higher thermal stability to withstand sterilization without coagulation
Raw milk selected for ultra-high temperature concentrated milk processing must possess exceptional thermal stability compared to milk destined for standard pasteurization. Concentration increases protein and salt density, which lowers the heat stability of the system. Therefore, the raw milk supply must have superior initial protein stability to withstand the sterilizing temperatures without suffering immediate thermal coagulation.

138. (A) Protein coagulation upon heating, indicating high acidity or poor salt balance
The clot-on-boiling test is a simple thermal assay that subjects milk to boiling temperatures for several minutes. If the milk has high acidity due to microbial fermentation, or if it possesses an unfavorable salt balance, the proteins will destabilize and coagulate. A positive test indicates that the milk is unsuitable for processing at high temperatures.

139. (B) Lactometer reading : Specific gravity (water adulteration)
A lactometer is a specialized hydrometer calibrated to measure the specific gravity of milk at a standardized temperature. Because water has a lower specific gravity than milk, any addition of water decreases the overall density of the sample. This rapid platform test allows quality control personnel to quickly detect illegal water adulteration in incoming milk supplies.

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140. (B) It provides a quicker, multi-stage colorimetric quality assessment
The resazurin test provides a rapid evaluation of milk quality by utilizing a dye that undergoes a series of color changes from blue to pink and finally to colorless. This allows for a multi-stage colorimetric assessment within a short incubation period, often just one hour. In contrast, the methylene blue reduction test requires continuous observation until complete decolorization occurs.

141. (A) II → I → III → IV
In a falling film evaporator, incoming milk first enters the pre-heaters to raise its temperature close to the boiling point. The hot liquid is then distributed at the top of the calandria tubes, where heating steam initiates evaporation. The resulting vapor-liquid mixture flows into a separator to isolate the concentrate, while vapors pass to the condenser.

142. (C) It consumes higher amounts of steam than a standard single-effect system
Mechanical vapor recompression systems are highly energy-efficient because they mechanically compress the low-pressure exhaust vapor from the evaporator, raising its pressure and temperature. This compressed vapor is then re-used as the heating medium in the same effect. This design dramatically reduces steam consumption compared to standard single-effect or multi-effect systems, saving operational costs.

143. (D) Dry spots, severe fouling, and reduced heat transfer
Efficient heat transfer in a falling film evaporator requires a continuous, thin film of milk flowing down the internal surface of the calandria tubes. Inadequate distribution of the liquid feed causes some tube surfaces to dry out. This results in localized overheating, leading to severe protein fouling, scorching, and a significant decline in overall heat transfer efficiency.

particles, turning the free-flowing powder into hard, insoluble lumps.

200. (C) Oxidized off-flavor development, requiring inert gas flushing
Storing whole milk powder in air-filled packaging exposes the milk lipids to atmospheric oxygen. This exposure drives lipid autoxidation, which breaks down unsaturated fatty acids into volatile aldehydes and ketones. These compounds produce cardboard-like, tallowy, and oxidized off-flavors, drastically reducing shelf life. To prevent this, commercial packaging requires inert gas flushing with nitrogen or carbon dioxide.

201. (D) Dispersibility and instant properties
Agglomeration is a physical modification process that binds fine, individual milk powder particles into larger, porous clusters. This structural rearrangement increases the interstitial spaces between particles, allowing water to enter rapidly via capillary action when reconstituted. This significantly enhances the instant properties of the powder, specifically improving its wettability, sinkability, and overall dispersibility in liquids.

202. (A) Agglomeration alone is sufficient to make WMP fully instant.
While agglomeration improves the physical porosity of whole milk powder, it is insufficient on its own to make the powder fully instant. The presence of hydrophobic free fat on the surface of the particles repels water, preventing wetting. To overcome this barrier, a surfactant like lecithin must be applied to cover the hydrophobic fat with a hydrophilic layer.

203. (B) Wettability, sinkability, dispersibility, and solubility
Reconstitution of instant dairy powders relies on four sequential physical stages. First, the powder must wet, allowing water to penetrate the pores. It then sinks into the liquid, disperses evenly without forming lumps, and finally dissolves completely to form a stable suspension. Evaluating these four parameters provides a comprehensive assessment of the powder's instant properties.

204. (B) Surface stickiness, causing particles to adhere into porous agglomerates
In a fluid bed agglomerator, spraying a fine mist of water or steam onto dry milk powder partially plasticizes the amorphous lactose on the particle surfaces. This induces localized surface stickiness, causing colliding particles to adhere to one another. Upon re-drying, these adhered particles form stable, porous, and highly dispersible clusters, enhancing the reconstitution properties of the powder.

205. (A) Spraying soy lecithin dissolved in butter oil onto powder in a fluid bed
Lecithinization is standardly performed by spraying a mixture of soy lecithin dissolved in butter oil onto the surface of milk powder particles inside a fluidized bed. This fine mist ensures a uniform coating of the surfactant over the individual particles, particularly covering any hydrophobic surface fat. This treatment significantly enhances the wettability of high-fat dairy powders.

206. (C) Very high bulk density
Instantized milk powders are characterized by large, porous agglomerates that contain significant interstitial air spaces. This clustered structure allows rapid capillary water penetration but physically increases the volume occupied by a given mass of powder. Consequently, instantized powders exhibit a lower bulk density compared to non-instantized powders, which consist of smaller, more densely packed individual particles.

207. (D) Agglomeration to create a porous, clustered structure
Skimmed milk powder lacks hydrophobic surface fat, meaning its instant properties depend primarily on its physical structure. Instantized skimmed milk powder requires an agglomeration process during or after drying to bind fine particles into larger, porous clusters. This open structure allows water to enter rapidly via capillary action, preventing the formation of wet, slowly dissolving lumps.

208. (C) The ability of particles to overcome surface tension and penetrate water
Wettability is a key physical parameter used to evaluate the instant properties of food powders. It is defined as the ability of dry powder particles to overcome surface tension, absorb water onto their surfaces, and sink below the liquid surface. This initial step is critical to facilitating subsequent dispersion and complete dissolution of the powder.

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209. (B) Sinkability : The rate at which wetted particles drop through the liquid profile
Sinkability is a specific reconstitution parameter that measures the ability of wetted powder particles to overcome buoyancy and drop through the liquid surface. This physical movement is essential to dispersing the powder throughout the liquid volume, preventing it from floating on the surface where it could form dry, slowly dissolving clumps at the air-water interface.

210. (D) High mechanical fragility, causing breakdown into dust during transport
The primary physical disadvantage of instantized agglomerated milk powder is the fragile nature of its porous clusters. These agglomerates are held together by weak lactose bridges that are highly susceptible to mechanical damage. During handling, packaging, and transport, physical friction breaks these clusters down into fine dust, reducing the instant properties of the product.

211. (A) Adjust macronutrient and micronutrient profiles to match human breast milk
Humanizing bovine milk involves altering its natural composition to closely resemble the nutritional profile of human breast milk. This process requires reducing the high protein and mineral concentrations of cow's milk to avoid renal stress in infants. It also involves adjusting the fat, lactose, and whey-to-casein ratios to match the developmental needs of infants.

212. (C) Standard bovine milk inherently possesses a 60:40 whey-to-casein ratio.
Standard bovine milk contains a high ratio of casein to whey proteins, typically around eighty to twenty. This composition is the opposite of mature human breast milk, which features a whey-to-casein ratio of approximately sixty to forty. Therefore, stating that cow's milk inherently possesses a sixty-to-forty ratio is incorrect, as this ratio must be engineered.

213. (A) Replace bovine milk fat with vegetable oil blends
Bovine milk fat has a higher concentration of saturated fatty acids and lower levels of polyunsaturated fatty acids compared to human breast milk. To mimic the human lipid profile, manufacturers replace bovine milk lipids with vegetable oil blends. These blends are formulated to provide essential fatty acids, such as linoleic and alpha-linolenic acids, necessary for infant development.

214. (D) The high mineral ash content of bovine whey would overload infant kidneys
Bovine whey naturally contains high concentrations of minerals, particularly sodium, potassium, and calcium. If added directly to infant formula, this elevated mineral load would exceed the filtration capacity of underdeveloped infant kidneys, causing metabolic stress. Demineralization processes, such as electrodialysis or ion exchange, remove these minerals, making the whey safe for infant consumption.

215. (B) Adding lactose to match the high carbohydrate content of human milk
Mature human milk contains a significantly higher concentration of carbohydrates, primarily lactose, than bovine milk. To match this nutritional profile, manufacturers must add purified lactose to bovine milk during formula preparation. This adjustment provides the primary energy source required by infants and supports the development of beneficial bifidobacteria in the gut.

216. (C) Live attenuated viral vaccines
Advanced infant formulas are supplemented with functional ingredients like arachidonic acid, docosahexaenoic acid, prebiotic oligosaccharides, and nucleotides to match the immunomodulatory and developmental benefits of breast milk. However, live attenuated viral vaccines are not added to infant formulas. Vaccines are administered separately under strict medical supervision and are not used as food ingredients.

217. (D) Lower total protein, higher lactose, and distinct immunoglobulins
Mature human breast milk differs significantly from bovine milk in its nutritional and immunological composition. It contains lower levels of total protein and minerals, which prevents renal stress in infants. Conversely, it has a higher concentration of lactose and contains unique bioactive proteins, such as lactoferrin and distinct immunoglobulins, which support infant immune development.

NODIA

218. (A) Complementary foods introduced during transition from milk diet to family foods
Weaning foods, also known as complementary foods, are specifically formulated nutrient-dense foods introduced to an infant's diet around six months of age. These foods facilitate the transition from an exclusive breast milk or formula diet to solid family foods. They provide essential micro- and macronutrients, particularly iron and zinc, to support rapid growth phases.

219. (B) Lowering total protein : Prevents metabolic and renal stress
Bovine milk contains high protein levels that exceed the nutritional requirements of human infants. Excess dietary protein produces high levels of urea, which can overload the glomerular filtration capacity of underdeveloped infant kidneys. Lowering the total protein concentration in infant formula directly prevents this metabolic and renal stress, matching the infant's physiological tolerance.

220. (B) Maintaining physical emulsion stability and preventing age gelation during storage
Manufacturing liquid, ready-to-feed infant formulas presents unique physical challenges during extended storage. Unlike dry powders, these liquid emulsions are susceptible to physical separation, including fat creaming and mineral sedimentation. Furthermore, the high thermal treatments required for commercial sterilization can damage proteins, making the liquid product highly vulnerable to age gelation and viscosity changes over time.

221. (A) Germination, activating amylolytic enzymes to hydrolyze starches
The malting of barley begins with controlled steeping and germination of the grains. This biological process activates endogenous amylolytic enzymes, particularly alpha-amylase and beta-amylase, which hydrolyze insoluble storage starches into soluble, fermentable sugars like maltose and dextrins. This conversion is essential to producing the sweet, nutrient-rich extract used in malted food formulations.

222. (C) Malted milk powder requires high pressure spray drying for its texture
Malted milk manufacture involves combining liquid malt extract with milk solids and evaporating the mixture. Traditionally, this concentrate is dried using vacuum pan or vacuum band dryers, which allow the product to expand into a characteristic porous, honeycomb structure. Spray drying is not typically used, as it would yield fine, dense particles lacking this traditional porous texture.

223. (D) Denaturation of diastatic enzymes, halting starch hydrolysis
During the mashing stage of malt extraction, controlled temperatures are maintained to optimize the activity of endogenous diastatic enzymes. If the temperature is raised above eighty degrees Celsius prematurely, these heat-labile amylases will undergo thermal denaturation. This loss of enzymatic activity halts the hydrolysis of barley starches into soluble sugars, severely reducing the yield and quality of the extract.

224. (C) Expansion of the product into a porous, honeycomb-like structure
Vacuum drying is a key process in malted milk production because it operates under reduced pressure, lowering the boiling point of water. As water vaporizes rapidly within the viscous concentrated mixture, it causes the product to expand or puff. Upon cooling and drying, this expansion creates a highly porous, honeycomb-like solid structure that is easily milled into powder.

225. (C) 40%
Food safety regulations, such as FSSAI standards, establish compositional requirements to define authentic malted milk foods. These standards specify that the product must contain a minimum of forty percent milk solids by weight on a dry basis. This requirement ensures that the food provides the necessary nutritional benefits, protein content, and dairy characteristics expected by consumers.

226. (D) Distillation to extract volatile alcohols
The mashing process is designed to extract soluble solids from malted barley through enzymatic activity. It involves mixing crushed malt with water, applying controlled temperature rests, and filtering the mixture to separate the sweet liquid wort from the insoluble grains. Distillation is not part of this process, as mashing avoids fermentation and contains no volatile alcohols to extract.

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(A) Eliminating the technological need for standard sanitary processing equipment
(B) Quantifying the combined inhibitory effects of applied hurdles on target pathogens
(C) Determining the precise sensory acceptance thresholds of added food preservatives
(D) Enhancing the overall nutritional and amino acid profile of the finished product

2001

42. Carbonation of milk alters its physical properties by:
(A) Dramatically increasing the freezing point profile of the milk
(B) Lowering the overall titratable acidity of the fluid permanently
(C) Shifting the calcium equilibrium causing protein destabilization
(D) Preventing Maillard browning during subsequent thermal processing

2022

43. Sodium caseinate is highly valued in dairy formulations primarily because its non-micellar structure provides exceptional:
(A) Resistance to basic enzymatic hydrolysis
(B) Crystallization control in frozen desserts
(C) Opacifying and natural coloring actions
(D) Emulsifying and fat-binding properties

2022

44. Whey Protein Concentrates (WPC) are utilized in meat processing primarily due to their superior:
(A) Gelation and water-holding capacity upon heating
(B) Ability to lower the pH of the meat matrix
(C) Proteolytic enzyme activity that tenderizes the meat
(D) Ability to act as a natural curing salt substitute

2010

45. In the production of stirred yogurt, excessive pumping shear post-fermentation will most likely result in:
(A) Enhanced microbial production of exopolysaccharide polymers
(B) Irreversible disruption of the gel network causing syneresis
(C) Increased metabolic acidification rates by starter cultures
(D) Immediate solidification of the liquid phase into a firm block

2022

46. The Specific Mechanical Energy (SME) in dairy extrusion processing quantifies:
(A) The thermal heat energy provided strictly by the external steam heating jacket
(B) The mechanical work transferred by the drive motor through the screws to the melt
(C) The latent heat of vaporization required to expand the moisture in the extrudate
(D) The total electrical energy required to operate the auxiliary product cooling fans

2010

47. Hard water interferes with dairy plant hygiene primarily because calcium and magnesium ions:
(A) React with alkaline cleaners and organic soils to form precipitates
(B) Denature active enzymes utilized in modern bio-detergent formulations
(C) Evaporate rapidly during sanitization cycles leaving pure water behind
(D) Lower the surface tension of the chemical cleaning solution too drastically

NODIA

2008

48. During biofilm maturation on dairy equipment, the irreversible attachment phase is characterized by:
(A) Weak physical forces keeping cells temporarily adjacent to the solid surface
(B) The progressive detachment and shedding of planktonic cells into flowing fluid
(C) Bacterial secretion of a robust extracellular polymeric substance matrix
(D) Complete susceptibility of the cellular layer to mild ambient water rinsing

2013

49. In CIP protocols, maintaining a turbulent flow (Reynolds number > 3000) is crucial because it:
(A) Induces rapid chemical neutralization reactions between acid and alkali
(B) Prevents concentrated chemical detergents from contacting stainless steel directly
(C) Significantly reduces the thermal energy requirements of the cleaning cycle
(D) Provides high mechanical scrubbing action at the equipment boundary layer

2019

50. Consider the following statements regarding dairy plant sanitizers:
I. Hypochlorites possess broad-spectrum antimicrobial activity but are inhibited by organic matter.
II. Peracetic acid leaves toxic residues that

CHAPTER 04
Advanced Dairy Processing

2012

1. What does the F-value explicitly indicate in the thermal destruction kinetics of milk processing?
(A) The temperature required to reduce the microbial population by one decimal logarithm
(B) The time required to achieve a specific proportional reduction of microbes at a constant temperature
(C) The rate at which whey proteins denature during pasteurization
(D) The total time in minutes required to destroy a specific number of microbes at a reference temperature

2019

2. Which operational characteristic defines an indirect tubular heating system in Ultra High Temperature (UHT) processing?
(A) Steam is directly injected into the milk stream to achieve rapid heating
(B) Milk flows in a continuous film through steam-filled chambers
(C) Heat transfer occurs across a physical stainless steel barrier separating milk and the heating medium
(D) Cavitation forces are utilized to simultaneously heat and homogenize the fluid

2001

3. What is the primary physico-chemical cause of increased heat stability in milk following pre-heating?
(A) Rapid enzymatic degradation of alpha-lactalbumin into free hydrophobic amino acids
(B) Association of denatured beta-lactoglobulin with kappa-casein on micelle surfaces
(C) Reversible solubilization of colloidal calcium phosphate into the surrounding serum phase
(D) Accelerated Maillard browning reactions converting reactive lactose into lactulose isomers

2004

4. In UHT processing plants, Type A fouling deposits are primarily composed of which constituents?
(A) Calcium phosphate precipitates with minor protein inclusion
(B) Exopolysaccharides and live microbial biofilms
(C) Carbonized lactose and oxidized lipid polymers
(D) Unfolded whey proteins cross-linked with casein micelles

NODIA

2014

5. According to Stokes' law, which parameter has an inverse relationship with the terminal settling velocity of a microbial spore during centrifugal separation?
(A) The dynamic viscosity of the continuous milk phase
(B) The square of the spore radius
(C) The density difference between the spore and milk serum
(D) The centrifugal acceleration applied by the bowl

2008

6. How does the Bactotherm process differ from standard one-phase bactofugation in extending milk shelf life?
(A) It permanently discards the dense spore-rich bactofugate fraction to prevent late fermentation defects
(B) It incorporates multi-stage microfiltration prior to the standard centrifugal separation of spores
(C) It sterilizes the spore-rich bactofugate via UHT treatment before recombination with the milk stream
(D) It completely replaces thermal pasteurization by utilizing extremely high centrifugal forces alone

2024

7. Which mechanism primarily drives the initial disruption of milk fat globules during conventional two-stage homogenization?

(A) High shear, turbulence, and cavitation forces as fluid exits the first-stage valve
(B) High-intensity ultrasonic cavitation generated by transducer arrays in the holding tube
(C) Thermal melting of the crystalline fat phase inside the secondary-stage homogenizing valve
(D) Spontaneous emulsification driven by the continuous addition of food-grade surfactants

2023

8. What structural alteration occurs to casein micelles during High-Pressure Homogenization (HPH) exceeding 200 MPa?
(A) Complete insolubilization and immediate precipitation of all major casein fractions
(B) Irreversible transformation of native casein into a rigid exopolysaccharide-like matrix
(C) Absolute protection of the micellar core preventing any significant physical modification
(D) Disruption into sub-micelles and subsequent aggregation into new protein networks

2012

9. Which fluid dynamics principle is predominantly exploited in the Z-type interaction chamber of a microfluidizer?
(A) Low-velocity laminar mixing
(B) High shear and impact against channel walls
(C) Gravitational settling of large dispersed droplets
(D) Evaporative cooling through sudden pressure drops

2018

10. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): Reverse Osmosis (RO) membranes allow the permeation of water while strictly retaining lactose, proteins, and minerals in milk concentration.
Reason (R): RO membranes function primarily on a size-exclusion mechanism with pore sizes ranging from 0.1 to 1.0 micrometers.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2009

11. Which rheological defect is most likely to develop in highly concentrated milk during prolonged ambient storage?
(A) Spontaneous conversion into a Newtonian fluid
(B) Sublimation of the remaining free water phase
(C) Immediate separation of lactose crystals leading to serum clarification
(D) Age gelation driven by the progressive interaction of protein complexes

2018

12. In the psychrometry of milk drying systems, what does the wet-bulb depression indicate?
(A) The difference between dry-bulb and wet-bulb temperatures, indicating air humidity
(B) The absolute thermodynamic pressure measured inside the main spray drying chamber
(C) The physical freezing point depression characteristic of the concentrated milk feed
(D) The specific humid volume of the exhaust air exiting the main separation cyclone

2001

13. Which atomization technique is best suited for producing milk powders with high bulk density and low occluded air?
(A) Two-fluid pneumatic nozzle atomization
(B) High-pressure single-fluid nozzle atomization
(C) Centrifugal rotary disc atomization
(D) Ultrasonic capillary atomization

2015

14. During the freeze drying of dairy products, the primary drying stage is fundamentally governed by which thermodynamic transition?
(A) Direct condensation of ambient water vapor into a liquid phase
(B) Sublimation of crystalline ice directly into water vapor
(C) Sorption and desorption of unfreezable chemically bound water
(D) Melting of ice into liquid water followed by thermal evaporation

2017

15. What is the fundamental mechanism by which lowered water activity (a_w) acts as a hurdle to microbial growth in intermediate moisture dairy foods?
(A) It restricts free water availability required for metabolic reactions and cellular turgor
(B) It systematically increases the intracellular

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pH environment of the target microorganisms
(C) It rapidly denatures structural proteins in the bacterial cell wall via thermal shock
(D) It completely halts essential oxygen transfer processes across the outer microbial membrane

2009

16. Which combination of hurdles is most critical in formulating a shelf-stable traditional milk product like peda?
(A) Low pH, incorporation of synthetic food antioxidants, and standard carbonation
(B) High water activity, addition of active lactic acid bacteria, and aseptic packaging
(C) High heat treatment, low water activity from added sugar, and desiccation
(D) Low redox potential, targeted multi-enzyme preservation, and microfiltration

2025

17. By which primary mechanism does carbonation extend the shelf life of liquid dairy beverages?
(A) By mechanically purging dissolved oxygen while excluding ambient air bubbles from the liquid
(B) By selectively coagulating whey proteins to entrap contaminating bacteria in an insoluble matrix
(C) By increasing total dissolved solids in order to significantly lower the system's water activity
(D) By forming carbonic acid, lowering pH, and exerting toxic effects on microbial cells

2022

18. The foaming capacity of whey protein isolates is fundamentally dependent on their ability to:
(A) Remain fully intact within their native, compactly folded globular structures during processing
(B) Hydrolyze directly into free hydrophobic amino acids upon intense mechanical agitation
(C) Diffuse rapidly to the air-water interface and unfold to form a cohesive viscoelastic film
(D) Bind selectively to native milk fat globule membranes to completely prevent lipid creaming

2002

19. When Skim Milk Powder (SMP) is incorporated into advanced bakery formulations, what is its primary technological role aside from nutritional fortification?
(A) Acting as a highly active primary chemical leavening agent that releases carbon dioxide
(B) Enhancing crust color via Maillard browning and improving moisture absorption capacity
(C) Preventing the high-temperature thermal gelatinization of wheat starch during baking
(D) Serving as a direct functional substitute for wheat gluten to provide structural elasticity

NODIA

2025

20. Match the fermented dairy defects in List I with their primary technological causes in List II.
List I: (Fermented dairy defect)
P. Excessive syneresis
Q. Post-acidification
R. Grainy texture
S. Ropiness
List II: (Technological cause)
1. Undesirable exopolysaccharide production by contaminant strains
2. High incubation temperature during fermentation
3. Continued activity of starter cultures during cold storage
4. Low total solids or insufficient heat treatment of the milk base
(A) P-3, Q-1, R-4, S-2
(B) P-2, Q-4, R-1, S-3
(C) P-1, Q-2, R-3, S-4
(D) P-4, Q-3, R-2, S-1

2012

21. Which operational characteristic provides twin-screw extruders a distinct advantage over single-screw extruders in texturizing dairy proteins?
(A) Positive displacement pumping action that is independent of material friction
(B) Complete absence of mechanical shear forces during structural texturization
(C) Sole reliance on external thermal steam jacketing for heating the product
(D) Inability to process high-moisture formulations containing dissolved proteins

2002

22. In the context of dairy plant hygiene, the Sinner's Circle designates four interdependent factors required for effective cleaning. Which of the following is NOT one of these four factors?
(A) Mechanical action
(B) Chemical concentration
(C) Biological load
(D) Thermal energy

2007

23. Quorum sensing in dairy biofilm formation specifically refers to:
(A) Cell-to-cell communication using signaling molecules to coordinate gene expression
(B) Spontaneous initial attachment of individual bacterial cells to clean stainless steel
(C) Physical shearing and detachment of mature biofilm clusters caused by turbulent fluid flow
(D) Chemical destruction of protective EPS matrices using high-concentration alkaline cleaners

2008

24. What is the main advantage of using bio-detergents containing proteases in Cleaning-in-Place (CIP) protocols for dairy plants?
(A) They completely dissolve stubborn mineral scales at a neutral pH level
(B) They sterilize internal surfaces by immediately halting all bacterial DNA replication
(C) They entirely eliminate the requirement for mechanical fluid velocity during cleaning
(D) They selectively degrade complex proteinaceous matrices within biofilms and fouling layers

2004

25. Which assessment method utilizes the luciferin-luciferase reaction to provide a rapid evaluation of surface sanitization effectiveness?
(A) Total Plate Count (TPC) swabbing
(B) ATP bioluminescence assay
(C) Polymerase Chain Reaction (PCR)
(D) High-Performance Liquid Chromatography (HPLC)

2016

26. In calculating the destruction kinetics of a thermophilic spore, a Z-value of 10°C means:
(A) A 10°C decrease in ambient temperature will instantly double the microbial death rate
(B) Processing temperature must be held precisely at 10°C above boiling for sterilization
(C) An increase in the processing temperature by 10°C reduces the D-value by 90%
(D) The target organism requires a minimum of 10°C increase to initiate thermal shock

2013

27. Scraped-surface heat exchangers are typically selected in UHT processing when the dairy product exhibits:
(A) Extremely low dynamic viscosity and high thermal conductivity
(B) A complete inability to withstand any mechanical agitation
(C) A significantly depressed freezing point during processing
(D) High viscosity or suspended particulates that cause rapid fouling

2004

28. Which Maillard reaction intermediate is frequently monitored as an intrinsic chemical marker of the heat load applied during UHT milk processing?
(A) Hydroxymethylfurfural (HMF)
(B) Diacetyl
(C) Lactic acid
(D) Free volatile fatty acids

2024

29. Type B fouling in UHT heat exchangers predominantly forms at temperatures above 110°C and is largely characterized by:
(A) Beta-lactoglobulin aggregation
(B) High accumulations of calcium phosphate
(C) Intact bacterial cell wall matrices
(D) Solidified triglyceride complexes

2008

30. Consider the following statements regarding centrifugal separation in the dairy industry:
I. Clarifiers are designed with a single liquid discharge phase to remove solid impurities.
II. Decreasing the density differential between fat and serum increases the separation efficiency.
III. Higher milk viscosity facilitates a faster rate of fat globule separation.
(A) I and II
(B) II and III
(C) I
(D) I and III

2016

31. The primary objective of cheese milk bactofugation is to prevent late-blowing defects by specifically removing:
(A) Spores of Clostridium tyrobutyricum
(B) Vegetative cells of Lactobacillus bulgaricus
(C) Coliform bacteria
(D) Bacteriophages

2006

32. Which phenomenon is responsible for over-homogenization defects, where fat clustering

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leads to increased viscosity rather than emulsion stability?
(A) Insufficient reduction in fat droplet size during the primary homogenization stage
(B) Excessive application of high-frequency ultrasonic defoaming forces in processing
(C) Depletion of free casein micelles needed to coat the newly expanded fat surface
(D) Premature thermal crystallization of butterfat inside the secondary homogenizing valve

2004
33. Which parameter in High-Pressure Homogenization (HPH) is directly responsible for initiating localized heating and microbial cell rupture?
(A) Prolonged residence time in the holding tube
(B) The static hydrostatic pressure prior to the valve
(C) The injection of steam directly into the homogenization chamber
(D) Extreme shear stress combined with intense cavitation phenomena

2001
34. In microfluidization, nanometer-scale droplet size reduction of dairy emulsions is achieved without the use of:
(A) Specially designed micro-channel interaction chambers
(B) Pressurized high-velocity colliding micro-streams
(C) Moving mechanical parts inside the homogenization zone
(D) Intrinsically generated high-intensity shear forces

2019
35. Ultrafiltration (UF) is extensively used in cheese manufacturing to concentrate milk. Which components primarily permeate through the UF membrane?
(A) Casein micelles and emulsified milk fat globules
(B) Water, lactose, and soluble monovalent salts
(C) Soluble whey proteins and colloidal calcium complexes
(D) Intact bacterial cells and bovine somatic cells

2003
36. How does severe evaporative concentration fundamentally alter the rheology of milk?
(A) It completely eliminates the natural yield stress of the processed fluid
(B) It converts the liquid into a Bingham plastic with no viscosity changes
(C) It induces permanent dilatant or shear-thickening rheological behavior
(D) It shifts the fluid behavior from Newtonian to pseudoplastic flow

NODIA

2015
37. During the constant-rate drying period of a milk droplet in a spray dryer, the temperature at the droplet surface remains constant and is approximately equal to:
(A) The wet-bulb temperature of the drying air
(B) The dry-bulb temperature of the drying air
(C) The boiling point of pure water under vacuum
(D) The glass transition temperature of lactose

2013
38. Agglomeration of milk powder during spray drying improves which specific functional property?
(A) Resistance to lipid oxidation
(B) Thermal stability during reconstitution
(C) Wettability and dispersibility
(D) The whiteness index of the powder

2014
39. During the secondary drying phase of freeze drying, moisture is removed primarily through:
(A) Desorption of molecularly bound water
(B) Sublimation of frozen crystalline ice
(C) Evaporation of residual liquid water
(D) Centrifugal separation of ice crystals

2008
40. Consider the following statements regarding Hurdle Technology:
I. Water activity manipulation primarily affects microbial homeostasis.
II. Decreasing pH specifically prevents the growth of all yeast species.
III. Redox potential can be lowered by the addition of ascorbic acid.
IV. Sub-lethal hurdle stress always completely halts microbial metabolism immediately.
(A) I and III
(B) I, II and IV
(C) II and IV
(D) I, III and IV

2017
41. When formulating a shelf-stable composite dairy dessert, the application of predictive microbiology primarily assists in:

2023

59. The intense cavitation experienced by milk in a microfluidizer is primarily the result of:

(A) The addition of pressurized nitrogen gas into the main interaction chamber
(B) High-frequency ultrasonic transducers embedded within the high-pressure pump
(C) The continuous use of liquid nitrogen cryogenic cooling jackets during runs
(D) Rapid pressure drops causing the formation and collapse of vapor bubbles

2016

60. Which of the following represents the correct sequence of membrane filtration processes in increasing order of membrane pore size?

(A) Reverse Osmosis, Nanofiltration, Ultrafiltration, Microfiltration
(B) Microfiltration, Ultrafiltration, Nanofiltration, Reverse Osmosis
(C) Reverse Osmosis, Ultrafiltration, Nanofiltration, Microfiltration
(D) Nanofiltration, Reverse Osmosis, Microfiltration, Ultrafiltration

2014

61. During the evaporation of milk in a falling film evaporator, Thermal Vapor Recompression (TVR) improves energy efficiency by:

(A) Recompressing high-pressure live steam using a high-efficiency centrifugal mechanical fan
(B) Entraining low-pressure secondary vapor with motive steam in a thermocompressor
(C) Using purely electrical resistance elements to heat the secondary vapor before recycling
(D) Condensing all generated secondary vapor immediately into large volumes of cold water

2013

62. Which structural change primarily accounts for the observed increase in viscosity when milk is concentrated via reverse osmosis at low temperatures?

(A) Complete structural denaturation of globular beta-lactoglobulin proteins
(B) Volumetric crowding of casein micelles and fat globules upon water removal
(C) The physical transition of the concentrated liquid into a crystalline solid state
(D) Spontaneous chemical precipitation of whey proteins out of the serum phase

2019

63. In dairy spray drying, an increase in the exhaust air relative humidity indicates:

(A) Higher evaporation rate or lower drying air temperature
(B) Improved thermal efficiency in the gas burner system
(C) A decrease in the moisture content of final powder
(D) Complete failure of the high-pressure spray nozzle

2001

64. The process of lecithination during spray drying is specifically aimed at improving which functional property of whole milk powder?

(A) Resistance to enzymatic browning reactions during prolonged storage conditions
(B) Free-flowing physical properties of the bulk powder in the dry state under pressure
(C) Cold-water wettability by modifying surface hydrophobicity of fat-coated particles
(D) Thermal heat stability and protein protection during subsequent baking

2014

65. To prevent structural collapse during the freeze drying of a dairy formulation, the product temperature must be maintained strictly below its:

(A) Thermodynamic boiling point under atmospheric processing pressure conditions
(B) Triple point temperature of pure water within the drying system vacuum
(C) Absolute zero temperature threshold where all molecular motion ceases
(D) Glass transition temperature (T_g') of the freeze-concentrated solute matrix

2019

66. Leistner's concept of Hurdle Technology relies on the premise that combining sub-lethal preservative factors achieves microbial stability through:

(A) Applying independent preservation factors that do not biochemically interact with one another
(B) Providing essential growth nutrients to competitive, non-pathogenic food spoilage organisms
(C) Depleting microbial energy as the cell maintains homeostasis against multiple stresses
(D) Completely removing all active water and moisture content from the intermediate food product

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require hot water rinsing.
III. Quaternary Ammonium Compounds (QACs) are highly effective against biofilms and are non-corrosive.
IV. Ozone leaves no chemical residue as it decomposes quickly to oxygen.
V. Iodophors are primarily utilized as alkaline sanitizers for heavy fat removal.
(A) II, III, IV and V
(B) I, II and IV
(C) I, III, IV and V
(D) I, III and IV

2022
51. The D-value of Bacillus stearothermophilus spores at 121°C is 1.2 minutes. If the initial population is 10^5 spores/mL, what is the processing time required to reach a population of $10^{\{-1\}}$ spores/mL at 121°C?
(A) 4.8 minutes
(B) 6.0 minutes
(C) 7.2 minutes
(D) 12.0 minutes

2014
52. Direct steam injection systems are often favored over indirect UHT systems when processing heat-sensitive liquid dairy products because they:
(A) Utilize significantly higher thermal processing times during operation
(B) Eliminate the need for downstream aseptic high-pressure homogenization
(C) Induce severe chemical Maillard browning which improves flavor profiles
(D) Provide rapid heating and cooling profiles, minimizing thermal damage

2022
53. The irreversible denaturation of beta-lactoglobulin during UHT treatment significantly affects rennet coagulation by:
(A) Blocking the kappa-casein cleavage site normally required by chymosin
(B) Converting all native casein fractions into non-protein nitrogen compounds
(C) Reversing the natural slightly acidic pH of milk to alkaline conditions
(D) Destroying all active ionic calcium fractions present in the milk serum

2002
54. To mitigate the formation of proteinaceous fouling in UHT heat exchangers, processors often utilize:
(A) Higher concentration levels of un-denatured whey proteins in the feed
(B) Direct addition of high-purity crystalline lactose prior to heating
(C) A pre-heating step to denature whey proteins before peak temperatures
(D) Slower bulk fluid velocities through the internal stainless heating tubes

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2024
55. What is the primary physical limitation in using standard centrifugal clarification to completely remove bacteria from milk?
(A) The bacteria have a density close to milk and are very small, yielding an extremely low settling velocity
(B) The dynamic viscosity of the milk at low processing temperatures is too low
(C) The applied centrifugal force chemically lyses the cells before separation
(D) Clarifier equipment only separates fluid phases based on color differences

2009
56. What is a significant technological challenge associated with operating a two-phase bactofuge?
(A) The absolute inability to remove anaerobic bacterial endospores
(B) Spontaneous fermentation of the milk stream inside the centrifuge
(C) The strict requirement to operate exclusively under vacuum conditions
(D) Continuous loss of milk solids into the heavy bactofugate fraction

2024
57. The size reduction of fat globules during milk homogenization prevents creaming in accordance with which fundamental physical law?
(A) Fick's Law of Diffusion
(B) Stokes' Law
(C) Boyle's Law
(D) Raoult's Law

2018
58. Compared to standard homogenization, High-Pressure Homogenization (HPH) has the unique potential to:
(A) Completely separate dispersed milk fat from the continuous aqueous serum phase
(B) Freeze the liquid product during the extreme pressure drop across the valve
(C) Inactivate vegetative microbial cells, potentially replacing thermal pasteurization
(D) Evaporate the entire moisture content of the milk stream instantaneously

227. (A) A highly hygroscopic, irregular, and crumbly texture

Vacuum-band drying yields a malted milk powder with a highly irregular, crumbly, and non-spherical particle structure. Because the product is dried as a puffed sheet under vacuum and then ground, the particles are jagged and have a large surface area. This physical structure, combined with high sugar content, makes the powder highly hygroscopic and susceptible to moisture absorption.

228. (C) Sweet, enzymatically extracted liquid containing maltose and dextrins

In malting and cereal processing, wort refers to the sweet, nutrient-rich liquid obtained from the mashing process. This liquid is separated from insoluble spent grains through filtration. It contains high concentrations of soluble carbohydrates, primarily maltose and maltodextrins, along with amino acids and minerals, serving as the core ingredient combined with milk in formulations.

229. (A) Barley malt : Source of amylases and distinct flavor

Barley malt is the primary ingredient in malted milk foods, serving a dual purpose. It provides active amylase enzymes that hydrolyze starches during mashing, and its high amino acid and reducing sugar content drives the Maillard reaction during drying. This reaction generates the characteristic malty flavor and golden color of the final product.

230. (D) Extreme hygroscopicity, requiring moisture-proof packaging to prevent collapse

The highly porous, honeycomb-like physical structure of vacuum-dried malted milk powder provides excellent dispersibility but presents storage challenges. This structure exposes a large surface area to the surrounding air, making the powder extremely hygroscopic. If exposed to environmental moisture, the particles rapidly absorb water, leading to physical structure collapse, severe caking, and lump formation during storage.

****

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2002

67. When designing an intermediate moisture dairy product (IMDP), the addition of glycerol serves fundamentally as a:
(A) Chemical cross-linking agent to solidify whey proteins under heat
(B) Humectant to lower water activity without causing crystallization
(C) Strong liquid acidulant to drop the system pH below 4.0 rapidly
(D) Specific metal chelating agent to remove calcium ions from solution

2008

68. The antimicrobial efficacy of dissolved CO_2 in carbonated dairy beverages is highly dependent on:
(A) The presence of synthetic emulsifiers in the system
(B) High pasteurization temperatures prior to gas injection
(C) The concentration of milk fat present in the beverage
(D) Storage temperature and the final pH of the product

2011

69. Which functional property of dairy caseinates makes them superior to whey proteins in the stabilization of meat emulsions (e.g., sausages)?
(A) Highly disordered, amphiphilic structure for rapid orientation at fat-water interfaces
(B) Their capacity to form highly rigid, irreversible heat-induced gels during thermal processing
(C) Their hydrophobic molecular nature preventing any structural interaction with water molecules
(D) Their elevated concentration of sulfur-containing amino acids that stabilize covalent bonds

2023

70. Arrange the following steps in the correct order for the preparation of a commercial stirred yogurt:
I. Cooling to 4°C and packaging
II. Homogenization and severe heat treatment (e.g., 90°C for 5 min)
III. Incubation at 42°C until pH 4.5 is reached
IV. Breaking the gel and pumping
(A) III - II - I - IV
(B) II - IV - I - III
(C) II - III - IV - I
(D) I - II - III - IV

2001

71. In single-screw extrusion of dairy-based snacks, how does thermomechanical processing specifically affect starch-protein interactions?
(A) It denatures proteins and gelatinizes starch, creating a cross-linked continuous melt
(B) It permanently separates raw starch granules from the protein matrix during flow
(C) It prevents thermal gelatinization of starch completely under high operating pressures
(D) It degrades both starch and protein fractions into highly volatile flavor compounds

2001

72. During the cleaning of dairy processing equipment, which chemical mechanism is primarily utilized by sodium hydroxide (alkali) to remove fat soils?
(A) Chelation of structural calcium ions
(B) Enzymatic hydrolysis of peptide bonds
(C) Sublimation of organic lipid deposits
(D) Saponification of lipids into soluble soaps

2017

73. Which phenomenon triggers the dispersion or sloughing phase of a mature dairy biofilm?
(A) Initial physical attachment of cells to the stainless steel conditioning layer
(B) Quorum-sensing autoinducers signaling internal nutrient depletion or overcrowding
(C) The application of low-pressure mechanical rinsing using ambient water
(D) The direct addition of a highly concentrated neutral pH buffer solution

2008

74. Enzymatic cleaners utilized in dairy CIP are particularly effective against complex biofilms because they:
(A) Create highly alkaline conditions that can damage the underlying stainless steel
(B) Inhibit intracellular metabolic pathways, destroying bacterial cells from within
(C) Specifically hydrolyze the EPS and proteinaceous matrix of the biofilm
(D) Generate high levels of localized mechanical fluid turbulence during the wash

2010

75. In ATP bioluminescence swabbing, the Relative Light Units (RLU) measured are directly proportional to:
(A) The specific population concentration of viable pathogenic bacterial cells only
(B) The residual concentration of chemical sanitizers remaining on the surface

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(B) P-1, Q-4, R-2, S-3
(C) P-2, Q-1, R-4, S-3
(D) P-4, Q-3, R-1, S-2

2007

91. When applying hurdle technology to produce intermediate moisture paneer, which hurdle is typically achieved through the addition of sorbic acid?
(A) Thermal inactivation of bacterial spores
(B) Lowering of the overall water activity
(C) Complete depletion of oxygen from the packaging
(D) Specific fungistatic inhibition of molds and yeasts

2013

92. The addition of pressurized carbon dioxide to raw milk for temporary preservation prior to processing primarily targets the inhibition of:
(A) Psychrotrophic spoilage bacteria like Pseudomonas species
(B) Thermoduric and thermophilic spore-forming bacilli strains
(C) Native milk proteolytic enzymes like active plasmin
(D) The chemical Maillard browning reaction during storage

2004

93. Whey proteins exhibit excellent gelation properties upon heating due to:
(A) Their highly linear, random-coil protein structures instantly aggregating upon heating
(B) Unfolding of structures to expose sulfhydryl groups for disulfide cross-linking
(C) The rapid thermal precipitation of intact native alpha-lactalbumin fractions in serum
(D) The targeted enzymatic cleavage of their specific peptide bonds by commercial proteases

2003

94. When butterfat is used as a shortening agent in high-quality baked goods, its primary functional role is to:
(A) Act as the sole leavening agent by trapping steam
(B) Interfere with gluten network formation, resulting in a tender, crumbly texture
(C) Accelerate the gelatinization of starch granules
(D) Provide a firm structural matrix capable of withstanding extreme mechanical shear

2004

95. In the manufacturing of set-type yogurt, which raw milk pre-treatment is essential to prevent syneresis during storage?
(A) Severe heat treatment to denature whey proteins and integrate them into the casein gel network
(B) Complete centrifugal separation of all fat globules to maximize the system's protein density
(C) Addition of high concentrations of calcium chloride to chemically precipitate proteins instantly
(D) Rapid chilling of the milk base to 4°C prior to starter culture inoculation procedures

2019

96. During the twin-screw extrusion processing of whey-fortified snacks, high Specific Mechanical Energy (SME) input typically results in:
(A) Minimal starch gelatinization
(B) Complete preservation of native whey protein structures
(C) High product expansion ratio and lower bulk density
(D) Prevention of any extrudate swelling at the die exit

2009

97. The phenomenon of "soil redeposition" during the cleaning cycle of a dairy plant occurs when:
(A) Cleaners have excessively high concentrations of active sequestering agents
(B) The final sanitizing rinse cycle utilizes low-temperature ultra-pure water
(C) The temperature of the alkaline wash step is maintained precisely at 70°C
(D) Surfactants are depleted or turbulence is insufficient to suspend soils

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2007

98. Which intrinsic characteristic of mature biofilms provides them with superior resistance to standard chemical sanitizers compared to planktonic cells?
(A) Their physical ability to migrate away from sanitized surface areas
(B) The exclusive presence of thick-walled Gram-positive bacterial cells
(C) A protective EPS matrix that restricts chemical sanitizer diffusion
(D) Their total reliance on active cellular aerobic respiration pathways

interactions holding sub-micelles together
(C) Complete enzymatic hydrolysis of the protective outer kappa-casein micellar layer
(D) Chemical chelation of all colloidal calcium phosphate by the homogenizing valve

2006
84. The Y-type interaction chamber in microfluidization facilitates droplet disruption primarily through:
(A) High-velocity impaction of the fluid stream against a solid static wall
(B) Rapid rotational spinning of an internal central rotor within a stator
(C) Ultrasonic wave generation from piezoelectric crystals in the chamber
(D) Collision of two high-velocity fluid streams directly with each other

2016
85. In electrodialysis of dairy whey, ion-selective membranes are utilized to separate components based primarily on their:
(A) Electrical charge under an applied direct current
(B) Molecular weight and specific hydrodynamic size
(C) Solubility in various non-polar organic solvents
(D) Susceptibility to physical thermal degradation

2010
86. How does severe pre-heating of milk before evaporative concentration influence its subsequent viscosity?
(A) It reduces the final product viscosity by thermally degrading lactose into simple reducing sugars
(B) It entirely prevents any viscosity changes during the subsequent thermal evaporation process
(C) It increases viscosity by promoting whey protein denaturation and complexation with casein micelles
(D) It completely reverses fluid mechanics, creating a fully Newtonian fluid during concentration

2010
87. In a spray dryer, utilizing a co-current flow configuration ensures that:
(A) Hottest air meets wettest droplets, maximizing evaporation while minimizing thermal damage to the product
(B) Hottest drying air encounters the driest powder particles near the discharge zone of the chamber
(C) Processing air flows horizontally while atomized droplets fall vertically through the chamber
(D) The final product requires intense post-drying fluid bed cooling to prevent thermal scorch defects

2021
88. The functional parameter "sinkability" of agglomerated milk powder describes its ability to:
(A) Repel atmospheric moisture during highly humid storage conditions
(B) Settle quickly at the bottom of the main spray drying chamber
(C) Resist chemical Maillard browning reactions at high temperatures
(D) Overcome surface tension and submerge into reconstituting water

2021
89. The use of cryoprotectants in freeze-drying dairy starter cultures aims to:
(A) Increase the sublimation rate of crystalline ice during primary drying
(B) Prevent cell damage from intracellular ice formation and osmotic stress
(C) Lower the pH of the culture medium to prevent microbial spoilage
(D) Denature the cellular wall structure to allow rapid rehydration

2011
90. Match the Hurdle Technology parameter in List I with its corresponding primary inhibitory mechanism in List II.

List I: (Hurdle Technology parameter)
P. Low Water Activity (a_w)
Q. Low pH
R. Added Nitrites/Nitrates
S. Low Redox Potential

List II: (Primary inhibitory mechanism)
1. Inhibition of essential metabolic enzymes and disruption of transmembrane proton gradients
2. Restriction of free moisture required for biological functions
3. Creation of anaerobic conditions restricting obligate aerobes
4. Interference with energy metabolism specifically in Clostridium species

(A) P-3, Q-2, R-1, S-4

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(D) IV - II - I - III

2009

141. By what specific mechanism does dissolved CO_2 inhibit microbial enzymes in carbonated dairy products?
(A) It strictly and continuously raises the intracellular pH of the target microbe
(B) It penetrates the membrane, dissociates into acid, and lowers internal pH
(C) It competitively binds to active catalytic sites of all known microbial lipases
(D) It rapidly and destructively oxidizes lipids within the outer bacterial cell wall

2008

142. The "Emulsifying Activity Index" (EAI) of a dairy protein mathematically describes:
(A) the absolute thermal energy required to denature the protein
(B) the interfacial area of oil stabilized per unit weight of protein
(C) the exact dynamic viscosity of the resulting emulsion measured at 4°C
(D) the physical time required for the emulsion to undergo phase separation

2009

143. When substituting a portion of egg white with Whey Protein Isolate (WPI) in aerated confectionary products (like nougat), the WPI must exhibit exceptional:
(A) foaming capacity and stability
(B) hydrophobic fat-binding properties
(C) rapid, uniform enzymatic rennet coagulability
(D) strong molecular calcium-chelating ability

2015

144. Which physical parameter is most critical to monitor when attempting to avoid syneresis in set yogurt immediately post-incubation?
(A) the exact initial concentration of native whey proteins in the starting milk
(B) the continuous mechanical agitation speed applied during the product cooling phase
(C) the rate of rapid, quiet cooling to prevent gel fracture and halt post-acidification
(D) the absolute headspace pressure maintained inside the closed fermentation container

2023

145. In single-screw extrusion, what primary function does the "metering zone" serve at the end of the screw?
(A) It provides the initial physical intake and rapid transport of the dry raw feed
(B) It continuously injects cold liquid water to rapidly cool down the extrudate
(C) It cleanly cuts or chops the finished hot extrudate into individual snack pieces
(D) It ensures a uniform melt and builds pressure to force material through the die

2006

146. Which characteristic of water hardness most severely compromises the action of anionic surfactants in dairy bio-detergents?
(A) the total concentration of dissolved oxygen molecules present within the cleaning water
(B) the naturally high alkaline pH value exhibited by the incoming hard source water
(C) divalent cations (Ca^{2+}, Mg^{2+}) forming insoluble complexes with surfactant
(D) the trace presence of residual free chlorine compounds from water treatment facilities

NODIA

2010

147. Biofilm dispersion, the final stage of the biofilm lifecycle, is technologically significant because it:
(A) signals the complete and highly spontaneous physical sterilization of equipment
(B) sheds viable cells into the milk stream, causing downstream contamination
(C) instantly converts the entire structural EPS matrix into highly soluble lactose
(D) permanently prevents any future bacterial colonisation or growth in the plant

2003

148. The primary objective of the initial warm water rinse in a standard dairy CIP program is to:
(A) completely and rapidly sterilize all internal food-contact equipment surfaces
(B) deposit a highly protective macromolecular conditioning layer on stainless steel
(C) melt and completely dissolve heavy, stubborn layers of mineral milkstone scale
(D) flush out loose residues to minimize chemical load in the alkaline wash

2016

149. ATP bioluminescence rapidly detects surface contamination; however, it cannot fundamentally distinguish between:
(A) ATP from viable microbial cells and ATP from somatic cells or raw milk debris
(B) highly concentrated acidic chemical residues and alkaline wash detergent traces
(C) polished food-grade stainless steel surfaces and vulcanized rubber gaskets
(D) distinct taxonomic groups of Gram-positive

2017

99. The most common chemical agent utilised in the acid wash phase of a dairy CIP protocol to remove milkstone deposits is:
(A) Sodium hydroxide
(B) Nitric acid
(C) Sodium hypochlorite
(D) Isopropyl alcohol

2010

100. Consider the following statements regarding sanitization in dairy processing:
I. Ozone is a weak oxidizing agent that leaves heavy chemical residues.
II. Peracetic acid maintains its efficacy across a wide temperature spectrum and is effective against spores.
III. ATP bioluminescence directly counts the exact number of pathogenic bacterial colonies on a surface.
(A) I and III
(B) II
(C) II and III
(D) I

2016

101. The Arrhenius equation is utilized in thermal processing to characterize:
(A) Temperature dependence of the reaction rate constant during inactivation or degradation
(B) The volumetric flow rate of non-Newtonian fluid passing through a stainless holding tube
(C) The exact particle size distribution of a newly homogenized oil-in-water emulsion
(D) The total hydrostatic pressure drop across an asymmetric microfiltration membrane

2012

102. Which specific component in a UHT plant is responsible for instantaneous cooling and removal of added water in a direct steam injection system?
(A) The plate heat exchanger regenerative section
(B) The aseptic homogenizer
(C) The vacuum expansion flash vessel
(D) The aseptic holding tube

2025

103. In UHT processing, the presence of surviving native plasmin during prolonged ambient storage primarily leads to:
(A) Age gelation and development of bitter flavor peptides
(B) Intense enzymatic browning of the milk serum phase
(C) Immediate crystallization and precipitation of lactose
(D) Spontaneous carbonation of milk inside the package

2025

104. Which operational adjustment is most practical to minimize the rate of Type A proteinaceous fouling in UHT systems?
(A) Increasing the temperature differential (ΔT) between the heating medium and the milk
(B) Decreasing the bulk fluid velocity through the heat exchanger
(C) Injecting compressed air into the milk line
(D) Implementing an appropriate pre-heating stabilization step

2015

105. In a solid-wall clarifier, how are the accumulated dense particulate solids traditionally managed?
(A) They are continuously discharged through peripheral nozzles during operation
(B) The centrifuge must be stopped, opened, and manually cleaned
(C) They are automatically ejected via a sliding bowl bottom mechanism
(D) They are dissolved by the addition of acid during separation

2004

106. What is the fundamental technological advantage of operating a bactofuge in a continuous, one-phase discharge mode?
(A) It completely sterilizes the bactofugate fraction within the centrifuge bowl
(B) It separates all lipid fat phases along with the targeted bacterial spores
(C) It eliminates milk solids loss by capturing spores for intermittent discharge
(D) It operates entirely on gravitational forces without requiring motorized drives

2018

107. According to emulsion science, the stability of a newly formed fat droplet during homogenization is critically dependent upon:
(A) Complete crystallization of core triglycerides within the fat globule during cooling cycles
(B) The immediate chemical addition of synthetic emulsifiers to stabilize the newly formed area
(C) The rapid thermal elevation of the milk product temperature immediately post-homogenization

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(A) The smooth, polished micro-topography of the stainless steel surface
(B) The rapid growth of planktonic bacterial cells floating free in milk
(C) The high turbulent velocity of the product flow inside the pipeline
(D) The highly hydrated Extracellular Polymeric Substance (EPS) matrix

2018

124. When optimizing CIP flow rates in dairy pipes, a minimum fluid velocity of 1.5 m/s is typically recommended to:
(A) Provide turbulent flow and mechanical shearing forces on the soil layer
(B) Achieve fully developed laminar flow conditions to reduce pipeline friction
(C) Prevent corrosive cleaning chemicals from reacting with the stainless steel
(D) Ensure the rapid, immediate condensation of steam within the heat exchanger

2011

125. The primary limitation of using hypochlorite sanitizers in dairy processing environments is:
(A) a complete inability to destroy common vegetative foodborne pathogens
(B) deactivation by organic matter and a potential to corrode stainless steel
(C) a strong tendency to form insoluble solid precipitates in cold water
(D) a relatively high purchasing cost compared to dilute peracetic acid

2010

126. A Z-value of 10.5°C indicates that the decimal reduction time (D-value) of a target microorganism will:
(A) remain constant regardless of changes in the processing temperature
(B) change tenfold when the processing temperature is altered by 10.5°C
(C) require exactly 10.5 minutes to achieve sterile conditions at 121°C
(D) increase exponentially as the processing temperature rises

2021

127. Steam infusion differs from steam injection in UHT processing primarily because in an infusion system:
(A) milk is sprayed into a large chamber filled with pressurized steam
(B) steam is injected directly into a fast-moving stream of liquid milk
(C) thermal energy transfer occurs across corrugated stainless steel plates
(D) no water is ever introduced or added directly to the milk phase

NODIA

2004

128. During UHT processing, the reaction between the free amino group of lysine and the reducing carbonyl group of lactose initiates:
(A) proteolysis
(B) lipid auto-oxidation
(C) the Maillard reaction
(D) lipolysis

2016

129. Pre-heating milk at 85°C to 90°C for several minutes prior to UHT treatment significantly reduces downstream fouling by:
(A) increasing the solubility and stability of native calcium phosphate
(B) destroying all structural integrity of milk fat globule membranes
(C) completely preventing the initiation of Maillard browning reactions
(D) promoting aggregation of beta-lactoglobulin with casein before peak heating

2001

130. Which of the following represents the correct sequence of phases in the formation of a bacterial biofilm on dairy equipment?
(A) conditioning layer formation, irreversible attachment, reversible attachment, maturation, dispersion
(B) reversible attachment, conditioning layer formation, maturation, irreversible attachment, dispersion
(C) conditioning layer formation, reversible attachment, irreversible attachment, maturation, dispersion
(D) irreversible attachment, conditioning layer formation, reversible attachment, dispersion, maturation

2022

131. The primary operational principle behind separating milk phases in a centrifuge relies on creating a field of acceleration that acts upon components exhibiting differences in:
(A) specific heat capacity of components
(B) specific gravity of the constituents
(C) net electrical charge of molecules
(D) refractive index of different phases

nutrient and free water availability
(B) Expend energy reserves trying to maintain homeostasis against multiple stresses
(C) Spontaneously mutate into active vegetative cells from protective endospores
(D) Enter an immediate, irreversible state of physical and cellular lysis

2002
116. Which specific hurdle combination is predominantly responsible for the extended shelf life of sweetened condensed milk?
(A) High-temperature UHT sterilization coupled with aseptic downstream packaging
(B) High hydrostatic pressure treatment paired with continuous product carbonation
(C) Low pH conditions combined with the addition of active lactic acid bacteria
(D) Reduced water activity (a_w) from added sucrose and hermetic sealing

2006
117. Carbonation of milk alters its sensory profile primarily by imparting:
(A) A pleasant effervescence, mild acidity, and masked cooked flavors
(B) An intensely sweet and lingering aftertaste in the finished milk
(C) A gritty, sandy mouthfeel from rapid, instant protein precipitation
(D) A highly caramelized, deep brown color change resembling dulce de leche

2014
118. The water-holding capacity (WHC) of whey protein isolates is highly dependent upon:
(A) The exact concentration of saturated and unsaturated fats within the lipid phase
(B) The total enzymatic or chemical elimination of all structural peptide bonds
(C) Protein concentration, pH, and ionic strength of the surrounding medium
(D) The absolute homogenization pressure applied during the initial processing stage

2013
119. When incorporated into bread formulations, Whey Protein Concentrate (WPC) can potentially depress loaf volume if:
(A) Its free sulfhydryl groups undergo disulfide exchange with gluten proteins, disrupting the gluten network
(B) It supplies excessive levels of fermentable lactose to the active yeast
(C) It possesses an excessively high water-holding capacity within the dough
(D) It completely halts the normal development of Maillard browning reactions

2021
120. Consider the following statements concerning fermented dairy products:
I. Post-acidification in yogurt is mainly caused by the continued metabolic activity of Streptococcus thermophilus at 4°C.
II. Excessive syneresis can be mitigated by utilizing EPS-producing starter cultures.
III. High incubation temperatures (e.g., 45°C) typically result in a smoother, finer yogurt gel network than lower temperatures.
IV. The gelation of yogurt occurs solely due to the enzymatic action of rennet.
V. A low total solids content in milk increases its susceptibility to whey expulsion.
Which of the following represents the INCORRECT combination of statements?
(A) I, II and IV
(B) I, III and IV
(C) II, III and V
(D) I, III, IV and V

2023
121. In extrusion processing, the transition of the dairy/starch feed into a fluid-like "melt" relies upon:
(A) Chemical cold solvent extraction of lipids and proteins inside the barrel
(B) Thermomechanical energy from external heaters and internal viscous shear
(C) The continuous injection of pressurized liquid nitrogen at the mixing zone
(D) High-frequency, low-amplitude ultrasonic vibration of the final die plate

2006
122. The term "contact time" in the Sinner's Circle of cleaning refers specifically to:
(A) The physical time taken by the plant operator to manually scrub the machines
(B) The cooling period required to bring equipment temperatures back to ambient
(C) The duration that the active cleaning solution remains in contact with soil
(D) The overall duration and volume flow rate of the final pure water rinse cycle

2017
123. The most challenging aspect of eradicating a mature dairy biofilm is overcoming the barrier presented by:

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(D) Rapid adsorption of milk proteins to lower interfacial tension and prevent coalescence

2012

108. Why is High-Pressure Homogenization (HPH) often coupled with a cooling mechanism immediately post-valve?

(A) To counteract adiabatic heat generated (approx. 2-3°C per 10 MPa) during pressure reduction

(B) To prevent the sudden boiling of liquid milk caused by the extreme pressure drops across the valve

(C) To initiate the crystallization of large structural ice networks within the aqueous milk serum

(D) To accelerate and promote the chemical Maillard browning reactions under hot operating conditions

2001

109. Cavitation within a microfluidization chamber directly causes droplet disruption through:

(A) Gentle swirling fluid movements induced within the micro-channels

(B) Shockwaves generated by the implosion of microscopic vapor bubbles

(C) Direct physical grinding action by high-speed rotating blades

(D) Electrostatic repulsion forces between newly formed fat particles

2019

110. Consider the following statements regarding membrane filtration in dairy processing:

I. Nanofiltration allows monovalent ions and water to permeate while retaining lactose and multivalent ions.

II. Microfiltration is commonly utilized to concentrate milk proteins for cheese making without fractionating casein and whey.

III. Reverse Osmosis operates at much lower trans-membrane pressures than Ultrafiltration.

IV. Cross-flow filtration systems suffer from instantaneous and permanent pore blockage (dead-end blinding).

(A) II, III and IV

(B) I and III

(C) III and IV

(D) I, II and IV

2013

111. What is the primary function of a mechanical vapor recompression (MVR) system in a modern falling film evaporator?

(A) To mechanically compress low-pressure vapor into heating steam, lowering steam use

(B) To compress atmospheric air for subsequent spray drying operations in the plant

(C) To cryogenically freeze the liquid feed prior to the evaporative concentration step

(D) To mechanically scrape internal fouling deposits from the inside of the heating tubes

2011

112. In spray dryer design, a rotary atomizer is generally preferred over high-pressure nozzles when processing:

(A) Extremely dilute, low-viscosity liquid dairy feeds

(B) Products requiring specific hollow-cone spray patterns

(C) Viscous or concentrated feeds that easily clog small orifices

(D) Small-scale batches of highly volatile flavor compounds

2005

113. The "stickiness" of spray-dried milk powder during production is predominantly governed by the physical state of which component?

(A) Crystalline lactose in the solid state under varying humidity levels

(B) Denatured beta-lactoglobulin protein aggregates on the particle surface

(C) Crystallized butterfat phases migrating to the outer particle boundary

(D) Amorphous lactose transitioning above its glass transition temperature (T_g)

NODIA

2015

114. During the freeze-drying process, what is the role of secondary drying?

(A) To remove bulk crystalline ice phase via sublimation under controlled low pressure

(B) To instantly flash-freeze the liquid feed prior to any primary drying steps

(C) To remove residual bound water by gradually raising temperature under high vacuum

(D) To rehydrate the dry powder prior to entering the final packaging process

2008

115. In Hurdle Technology, "metabolic exhaustion" occurs when microorganisms:

(A) Grow uncontrollably due to excessive

2018

132. The disruption of casein micelles during High-Pressure Homogenization can be technologically advantageous for producing:
(A) clear, highly transparent whey beverages with long shelf stability
(B) reconstituted milk powders that must remain completely illogical
(C) butter formulations with extremely large, brittle lipid crystals
(D) acid gels (like yogurt) with high firmness and reduced syneresis

2023

133. Which parameter limits the maximum concentration achievable when evaporating milk in a standard falling film evaporator?
(A) boiling point elevation and extreme viscosity increase impeding heat transfer
(B) the complete chemical degradation and corrosion of the stainless steel tubes
(C) the sudden, uncontrolled vaporization and loss of volatile milk fat components
(D) the total mechanical inability of industrial vacuum pumps to run continuously

2009

134. In cross-flow membrane filtration, the feed flows tangentially across the membrane surface primarily to:
(A) prevent any hydrostatic pressure drop across the active membrane layers
(B) ensure that all feeding liquid instantly permeates the membrane barrier
(C) induce shear to sweep away deposits, reducing polarization and fouling
(D) create a perfect, uninterrupted laminar flow profile across the channel

2011

135. The term "concentration polarization" in dairy membrane processing refers to:
(A) the accumulation of retained solutes forming a concentrated boundary layer
(B) the magnetic alignment of polar dipole molecules under high pressure
(C) the irreversible physical failure and tearing of the membrane material
(D) the selective separation of whey proteins from casein based on charge

2015

136. When operating a dairy spray dryer, lowering the feed temperature significantly will likely result in:
(A) a drastic and highly beneficial reduction in the volume of air required for drying
(B) the complete prevention of any heat-induced Maillard browning in the milk powder
(C) immediate, spontaneous thermal combustion of fine dust inside the drying chamber
(D) higher feed viscosity, deteriorating atomization and yielding larger particles

NODIA

2005

137. Which property dictates the physical transition of amorphous lactose from a brittle, glassy state to a sticky, rubbery state during spray drying?
(A) the specific heat capacity of the amorphous lactose and protein mixture
(B) the glass transition temperature (T_g), depending on moisture content
(C) the latent heat of vaporization associated with the bound water molecules
(D) the apparent isoelectric point of the system's dominant milk proteins

2001

138. Sublimation in freeze-drying bypasses the liquid state entirely by maintaining the operational environment strictly below the:
(A) boiling point of milk fat
(B) isoelectric point of casein
(C) triple point of water
(D) freezing point of pure lactose

2001

139. In the context of Hurdle Technology, "predictive microbiology" utilizes mathematical models primarily to:
(A) estimate the exact commercial cost of all chemical preservatives utilized
(B) design the physical and mechanical layout of the dairy processing plant
(C) formulate the precise and complete nutritional profile of the end product
(D) predict microbial survival or growth under defined hurdle combinations

2021

140. Arrange the following processes in the correct order for manufacturing a fully soluble, agglomerated skim milk powder:
I. Pre-heating and pasteurization
II. Spray drying in the primary chamber
III. Fluid bed drying and cooling (agglomeration)
IV. Vacuum evaporation
Arrange the processes from first to last:
(A) I - IV - II - III
(B) IV - I - III - II
(C) I - II - IV - III

(C) The exact taxonomic genus classification of the contaminating bacterial strain
(D) Adenosine triphosphate present from both microbial and food residue sources

2008

76. The "12D concept" is historically foundational to the commercial sterilization of low-acid foods. What does it strictly imply?
(A) Applying a thermal process to achieve a 12-log reduction of Clostridium botulinum spores
(B) Holding the food product inside the retort system at 121.1°C exactly for 12 continuous minutes
(C) Utilizing 12 distinct sequential preservation hurdles to ensure complete microbial stability
(D) Extending the room-temperature shelf life of the packaged product by precisely 12 months

2012

77. Which statement best characterises the flow profile of milk in an indirect plate heat exchanger during UHT processing?
(A) Laminar flow profiles with minimal fluid cross-mixing
(B) Turbulent flow induced by corrugated plate patterns
(C) Complete physical stagnation in peripheral channels
(D) Cavitational flow causing instantaneous boiling of milk

2022

78. Which biochemical reaction pathway is strictly responsible for the formation of lactulose during the severe heat treatment of milk?
(A) Enzymatic oxidation of long-chain saturated fatty acids by heat-stable lipases
(B) Isomerization of lactose via the Lobry de Bruyn-Alberda van Ekenstein reaction
(C) Hydrolysis of micellar beta-casein fractions by active native plasmin enzymes
(D) Microbial fermentation of galactose sugars by active thermophilic bacterial spores

2021

79. When designing UHT holding tubes, the holding time is calculated based on the fluid's:
(A) Maximum velocity in the flow profile to ensure the fastest particle receives adequate heat
(B) Average fluid velocity calculated across the entire cross-section of the holding tube
(C) Minimum velocity at the pipe wall boundary layer under fully developed laminar flow
(D) Rheological viscosity index measured immediately prior to the thermal pre-heating step

2021

80. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): Self-desludging centrifugal separators have replaced traditional solid-wall separators in modern continuous dairy processing plants.
Reason (R): Self-desludging centrifuges periodically discharge accumulated solids without requiring the machine to be halted and dismantled.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2014

81. In the Bactotherm process, what physical treatment is specifically applied to the dense, spore-rich bactofugate phase?
(A) High-pressure homogenization
(B) Intense ultra-violet (UV) irradiation
(C) Cold microfiltration through ceramic membranes
(D) Direct UHT steam injection up to 130–140°C

2023

82. Which parameter governs the magnitude of the Laplace pressure opposing the disruption of a milk fat globule during homogenization?
(A) The hydrostatic pressure measured within the raw milk balance tank
(B) The melting point of core triglycerides within the fat globule core
(C) Globule radius and interfacial tension between fat and serum phases
(D) The level of dissolved oxygen present within the continuous milk phase

2022

83. The primary cause of casein micelle disintegration during High-Pressure Homogenization (> 200 MPa) is:
(A) Thermal degradation of primary peptide bonds within the protein backbone structures
(B) Disruption of hydrophobic and electrostatic

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and Gram-negative bacterial species

2025

150. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): Quaternary Ammonium Compounds (QACs) are extensively utilized as surface sanitizers in dairy plants.
Reason (R): QACs possess excellent residual antimicrobial activity on surfaces and are relatively non-corrosive to stainless steel.
(A) Both (A) and (R) are true and (R) is the correct explanation of (A).
(B) Both (A) and (R) are true but (R) is not the correct explanation of (A).
(C) (A) is true but (R) is false.
(D) (A) is false but (R) is true.

2005

151. Which factor determines the slope of a thermal death time curve plotted on semi-logarithmic paper?
(A) the thermal resistance constant (Z-value) of the target microbe
(B) the decimal reduction time (D-value) determined at a constant temperature
(C) the initial concentration of the target bacterial population (N_0)
(D) the specific thermodynamic heat capacity of the gaseous heating medium

2004

152. To prevent immediate boiling of UHT-treated milk upon exiting a direct steam injector (at 140°C), the holding tube must be operated:
(A) under a high-strength industrial vacuum to induce instantaneous boiling
(B) at ambient atmospheric pressure conditions without any artificial control
(C) using purely natural gravitational forces to accelerate the fluid flow
(D) under a counter-pressure exceeding the saturated vapor pressure of water

2025

153. Heat-induced interactions between whey proteins and casein micelles predominantly occur via:
(A) the direct, covalent binding of structural lipids
(B) disulfide interchange reactions with kappa-casein
(C) the total enzymatic hydrolysis of alpha-casein fractions
(D) extensive hydrogen bonding with dissolved lactose molecules

2015

154. Which specific modification is commonly implemented in UHT indirect heat exchangers to delay the onset of severe mineral fouling?
(A) Operating the heat exchanger system exclusively at low pH values below 4.6
(B) Continuously injecting concentrated liquid calcium chloride into the feed stream
(C) Using a protein stabilization tube and small plate temperature differences
(D) Using highly porous, chemically inert ceramic plates instead of stainless steel

2009

155. In a centrifugal disc separator, the presence of conical closely-spaced discs serves specifically to:
(A) drastically decrease the overall rotational speed of the centrifuge bowl
(B) mechanically slice and shear fat globules into smaller, uniform fragments
(C) provide constant thermal heating to the process fluid during separation
(D) decrease the settling distance, greatly increasing separation efficiency

2019

156. The use of a "Bactofuge" is fundamentally more efficient at removing spores than vegetative cells because:
(A) spores have higher density, maximizing the density differential in Stokes' equation
(B) spores inherently possess a strong surface electrical charge repelling them from discs
(C) spores are lighter than the continuous fat phase and rise rapidly to the bowl center
(D) spores secrete active natural surfactants that chemically assist their separation

2016

157. According to homogenization theory, the phenomenon where a newly disrupted fat globule immediately merges with another prior to being coated by protein is called:
(A) flocculation
(B) coalescence
(C) syneresis
(D) creaming

NODIA

2021

158. High-Pressure Homogenization (HPH) has been researched for use in raw milk processing primarily due to its potential to:
(A) completely separate all lactose from the milk serum phase

oxygen from the formulation

2008

208. High-pressure homogenization can modify the functional properties of milk proteins, occasionally improving acid gelation properties by:
(A) removing all calcium and phosphate ions completely from the micellar core
(B) transforming casein molecules completely and irreversibly into whey protein
(C) inducing whey protein unfolding to foster interaction with casein micelles
(D) drastically increasing the total fat globule content of processed milk

2023

209. Microfluidization achieves exceptionally narrow droplet size distributions in emulsions primarily because:
(A) the processed fluid is allowed to settle gravitationally for highly extended periods
(B) it continuously incorporates very high levels of synthetic emulsifiers during flow
(C) it solely and completely relies on slow, gradual heating profiles across tubes
(D) chamber design subjects the entire stream to uniform, intense shear and impact

2014

210. Match the cleaning agent characteristic in List I with its corresponding primary function in dairy CIP in List II:
List I: (Cleaning Agent Characteristic)
P. Alkalinity (NaOH)
Q. Acidity (HNO_3)
R. Surfactants
S. Chelating agents (EDTA)
List II: (Primary Function)
1. Lower surface tension and improve penetration into soils
2. Prevent mineral precipitation and remove water hardness
3. Dissolve milkstone and inorganic mineral scales
4. Saponify fats and solubilize proteins
(A) P-4, Q-3, R-1, S-2
(B) P-3, Q-4, R-2, S-1
(C) P-1, Q-2, R-3, S-4
(D) P-2, Q-1, R-4, S-3

2011

211. Membrane fouling during Ultrafiltration of whey typically results in:
(A) a permanent and continuous increase in active permeate flux over time
(B) a gradual decline in permeate flux and altered solute rejection profiles
(C) the immediate, catastrophic mechanical rupturing of active membrane layers
(D) the rapid, spontaneous biochemical conversion of whey directly into casein

2008

212. In the design of a falling film evaporator for milk, proper distribution of the feed liquid at the top of the heating tubes is critical to:
(A) prevent the liquid from boiling before entering the tubes
(B) allow the feed liquid to completely bypass the heating tubes
(C) achieve immediate mechanical freezing of the internal vapor phase
(D) maintain a uniform, thin film along the inner tube wall, preventing dry-out and burn-on

2002

213. The "wet-bulb temperature" measured in the exhaust air of a spray dryer provides a close approximation of:
(A) product temperature during constant rate drying, when surfaces are fully saturated
(B) the absolute maximum temperature that powder particles reach during the process
(C) the theoretical flame temperature of the high-capacity combustion burner
(D) the actual freezing point temperature of the liquid incoming concentrate feed

2016

214. Which physical parameter explicitly indicates the amount of occluded (entrapped) air within spray-dried milk powder particles?
(A) the absolute moisture content measured via oven drying
(B) the solubility index in cold water
(C) particle density compared to the true density of the solid phase
(D) the exact colorimetric lightness (L value)

2012

215. The addition of cryoprotectants like sucrose or trehalose before freeze-drying biological cultures predominantly helps stabilize the proteins by:
(A) forming hydrogen bonds to substitute for removed water, maintaining folded structures
(B) rapidly and continuously increasing the electrochemical pH of the medium to 8.5
(C) extensively oxidizing free sulfhydryl groups on the surface of milk proteins

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and simultaneously attack cell membranes
(B) the low pH environment immediately freezes all remaining free water in food
(C) sub-lethal pH and a_w levels force the cell to expend excessive metabolic energy on homeostatic pumps, leading to metabolic exhaustion
(D) the specific product formulation induces rapid, spontaneous internal heating

2004

167. During the carbonation of milk, the resulting drop in pH is primarily caused by:
(A) the chemical dissociation of carbonic acid into bicarbonate and hydrogen ions
(B) the continuous metabolic lactic-acid-producing activity of starter cultures
(C) the direct, acid-induced chemical precipitation of basic casein proteins
(D) the slow chemical oxidation of lactose into lactic acid by dissolved oxygen

2024

168. Heat-induced gelation of whey proteins is fundamentally dependent upon the protein unfolding and subsequently:
(A) remaining completely and permanently isolated in aqueous suspension
(B) hydrolyzing rapidly and continuously into smaller peptide fragments
(C) evaporating directly into a highly volatile and gaseous thermal state
(D) forming a 3D network via hydrophobic interactions and disulfide bonds

2025

169. When Buttermilk Powder (BMP) is utilized in bakery products, its superior emulsifying capacity compared to Skim Milk Powder (SMP) is attributed to:
(A) its significantly and consistently higher content of fermentable lactose
(B) residual Milk Fat Globule Membrane (MFGM) fragments rich in phospholipids
(C) a completely different and highly functional structural form of casein
(D) the absolute and total absence of any functional native whey proteins

2025

170. Consider the following statements regarding rheological defects in fermented milks:
I. Syneresis can be strictly eliminated by incubating the milk at extreme temperatures (e.g., 55°C).
II. Low incubation temperatures generally result in longer fermentation times but produce firmer, less syneretic gels.
III. Ropiness is a defect caused strictly by over-homogenization of the milk base.
Which of the following represents the correct combination of statements?
(A) I and II
(B) II
(C) I and III
(D) II and III

NODIA

2014

171. In twin-screw extrusion, what specific geometrical feature prevents the product from adhering to the screws and rotating with them (co-rotating systems)?
(A) the smooth, virtually frictionless interior surface of the barrel wall
(B) the extremely high moisture content and low viscosity of the feed
(C) the constant presence of a strong electromagnetic field around screws
(D) the intermeshing action of the screws continuously wiping each other

2023

172. The "Mechanical action" factor in the Sinner's Circle of CIP primarily relies on:
(A) maintaining high fluid velocity and turbulence to scour away soils
(B) the chemical action of highly concentrated, hot nitric acid solutions
(C) the specific thermal heat capacity value of the cleaning detergent
(D) manual mechanical scrubbing of the pipeline interior by plant operators

2006

173. Quorum sensing in a biofilm matrix depends entirely upon the local concentration of:
(A) dissolved oxygen within the liquid film
(B) secreted signaling molecules, such as autoinducers like lactones
(C) the presence of active, external chemical sanitizing compounds
(D) the baseline availability of free divalent calcium ions in solution

2007

174. The inclusion of complexing agents (chelators) like EDTA in dairy detergents primarily aims to:
(A) provide a pleasant and masking synthetic odor to the cleaning solution
(B) bind calcium and magnesium to prevent

Which of the following represents the INCORRECT combination of statements?
(A) I and III
(B) II and IV
(C) III and V
(D) I, II and IV

2011
191. In intermediate moisture foods (IMF), the primary concern limiting extreme reduction of a_w through humectant addition alone is:
(A) unacceptable sensory profiles such as extreme sweetness or saltiness
(B) the spontaneous biological generation of excessive in-package carbonation
(C) the rapid physical aggregation and precipitation of intact milk fat globules
(D) the immediate, chemical-induced destruction of the plastic packaging material

2002
192. Carbonation is sometimes utilized in the manufacturing of cottage cheese primarily to:
(A) increase the overall technological yield by thermally coagulating whey proteins
(B) create a highly desirable, expanding micro-foam physical structure in the curd
(C) lower wash water pH, inhibiting psychrotrophic spoilage organisms during storage
(D) completely replace any technological necessity for continuous pasteurization

2016
193. The foaming stability of a whey protein concentrate solution is critically reduced by the presence of:
(A) high levels of intact, un-hydrolyzed lactose molecules in solution
(B) the baseline concentration of dissolved, highly soluble calcium phosphate minerals
(C) high saturation levels and concentrations of dissolved oxygen within the medium
(D) residual fat competing at interfaces and disrupting the viscoelastic protein film

2003
194. Why are dairy caseinates often preferred over whey proteins in the formulation of non-dairy coffee creamers?
(A) caseinates rapidly denature, aggregate, and precipitate in hot, acidic coffee
(B) caseinates completely and reliably resist any downstream Maillard browning
(C) disordered caseinate structures adsorb rapidly, forming highly stable emulsions
(D) caseinates provide a much stronger, highly rigid and cohesive gel structure

2022
195. In the production of fermented dairy beverages, exopolysaccharide (EPS) producing starter cultures are intentionally selected to:
(A) hasten the overall lactic acid fermentation time drastically in fermenters
(B) improve rheological properties, enhance viscosity, and prevent syneresis
(C) lower the product pH to extreme, highly acidic levels (typically below 3.0)
(D) completely and rapidly eliminate all remaining traces of residual lactose

2010
196. The "post-acidification" defect in yogurt during cold storage is predominantly driven by:
(A) the spontaneous chemical breakdown of lactic acid into highly volatile acetic acid
(B) the continuous, unchecked multiplication of active Streptococcus thermophilus cells
(C) rapid and highly aggressive proliferation of contaminating aerobic environmental molds
(D) survival and continued metabolism of Lactobacillus bulgaricus under refrigeration

2019
197. During twin-screw extrusion, an excessive increase in barrel temperature beyond the optimal processing range can result in:
(A) severe protein degradation and an unacceptably dark, burnt extrudate
(B) highly incomplete and insufficient gelatinization of feed starches
(C) a complete and sudden cessation of all internal mechanical friction
(D) extreme, highly problematic increases in final product moisture levels

2021
198. The Sinner's Circle parameter of "Temperature" in CIP applications must be carefully optimized because excessively high temperatures in the alkaline wash can:
(A) increase the overall catalytic efficiency of enzymatic cleaning agents indefinitely
(B) promptly and severely melt or deform the stainless steel processing pipelines
(C) cause irreversible bake-on of proteins, making them much harder to remove
(D) spontaneously generate highly unstable, explosive gaseous mixtures in the lines

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(C) second stage breaks up fat clusters formed in the first, preventing creaming
(D) the second stage acts as an efficient centrifugal separator to remove impurities

2012
183. The intense localized forces in microfluidization are particularly advantageous over standard homogenization for producing:
(A) stable nano-emulsions for encapsulating bioactive compounds
(B) butter formulations with large agglomerated fat crystals
(C) coarsely structured, high-moisture variety cheese curds
(D) instant milk powders exhibiting extremely low wettability

2008
184. In membrane filtration, the metric "Molecular Weight Cut-Off" (MWCO) defines the:
(A) complete physical mass and weight of the structural membrane module
(B) absolute maximum operating pressure that the membrane can withstand
(C) total cumulative volume of pure water permeated through the unit per hour
(D) lowest molecular weight of a solute retained at a specified efficiency

2013
185. When reverse osmosis (RO) is used to pre-concentrate milk prior to evaporation, its primary economic benefit lies in:
(A) the complete thermal inactivation and destruction of thermoduric enzymes
(B) water removal without phase change (latent heat), lowering energy costs
(C) the total physical elimination and exclusion of the homogenization step
(D) the permanent prevention and absolute control of downstream age gelation

2011
186. Which rheological model best describes the flow behavior of highly concentrated whole milk prior to spray drying?
(A) ideal, temperature-independent Newtonian fluid
(B) shear-thickening, highly dilatant product fluid
(C) shear-thinning fluid with a yield stress
(D) perfectly elastic, non-deformable solid phase

2019
187. In spray drying, what does the functional parameter "dispersibility" specifically measure?
(A) the exact speed at which dry milk powder sinks to the bottom of a cold water beaker
(B) the maximum structural heat stability exhibited by the reconstituted milk powder
(C) the total amount of free surface fat that can be extracted using organic solvents
(D) the ability of wetted particles to separate and distribute evenly in water without lumps

2019
188. Agglomeration of spray-dried milk powder structurally involves:
(A) re-weting fine particles to make them sticky, forming porous clusters upon collision
(B) mechanical grinding of the dried particles into an extremely fine, dust-like consistency
(C) melting the milk powder completely back into liquid form and then rapidly re-freezing it
(D) coating individual dried particles entirely in a thick, protective layer of pure butterfat

2019
189. During lyophilization, structural collapse of the product cake occurs if the temperature exceeds the glass transition temperature (T_g'). This collapse results directly in:
(A) a significant, highly rapid and uncontrolled increase in the sublimation rate
(B) loss of porous cake structure, causing poor rehydration and high residual moisture
(C) instantaneous, highly destructive and spontaneous thermal combustion of cake
(D) complete physical denaturation and disruption of all native casein micelles

NODIA

2015
190. Consider the following statements regarding Hurdle Technology combinations:
I. A reduction in a_w generally increases the thermal resistance (D-value) of bacterial spores.
II. Adding sodium chloride lowers the redox potential significantly.
III. High acidity (low pH) acts synergistically with mild heat to increase microbial lethality.
IV. Preservatives like sorbates are most effective in their dissociated ionic state at alkaline pH.
V. Modified atmosphere packaging can serve as an independent hurdle against obligate aerobes.

2006

224. In the Sinner's Circle for dairy plant cleaning, if the cleaning temperature must be strictly reduced due to energy constraints, an equivalent cleaning efficiency can theoretically be maintained by:
(A) decreasing the mechanical flow velocity and fluid turbulence
(B) reducing the overall concentration of the chemical detergent
(C) increasing the chemical concentration or extending contact time
(D) decreasing the total volume of cleaning water used entirely

2007

225. Match the biofilm lifecycle stage in List I with its defining molecular or structural characteristic in List II:
List I: (Biofilm Lifecycle Stage)
P. Conditioning
Q. Initial Adhesion
R. Maturation
S. Dispersion
List II: (Defining Characteristic)
1. Secretion of a complex 3D Extracellular Polymeric Substance (EPS) matrix
2. Reversible attachment influenced by weak Van der Waals forces
3. Adsorption of organic milk macromolecules (proteins/fats) onto bare stainless steel
4. Triggered release of motile planktonic cells due to nutrient depletion signals
(A) P-3, Q-2, R-1, S-4
(B) P-4, Q-3, R-2, S-1
(C) P-1, Q-4, R-3, S-2
(D) P-2, Q-1, R-4, S-3

2003

226. In assessing D-values during thermal processing, if organism A has a D-value of 2 minutes at 110°C, and organism B has a D-value of 5 minutes at 110°C, which statement is true?
(A) organism A is substantially more heat-resistant than organism B
(B) both organisms will die at exactly the same rate if the temperature is raised to 121°C
(C) organism B is substantially more heat-resistant than organism A
(D) organism B cannot be destroyed by thermal processing

2007

227. An indirect tubular heat exchanger in a UHT plant is generally preferred over a plate heat exchanger when the product:
(A) requires absolutely minimal, near-zero pressure drops across the entire piping system
(B) contains particulate matter or high viscosity that would block narrow plate channels
(C) must never, under any operating circumstances, be exposed to temperatures over 72°C
(D) exhibits an extremely low total solids content resembling thin, clarified whey

2008

228. The formation of lactulose during the UHT treatment of milk is widely recognized as a useful indicator of:
(A) the absolute achievement of complete microbial sterility
(B) the total and permanent inactivation of native milk lipases
(C) the precise concentration of fat in the starting raw milk feed
(D) the severity of the thermal heat load applied during processing

2022

229. Type B fouling in UHT heat exchangers, which occurs predominantly at temperatures exceeding 110°C, poses a significant cleaning challenge primarily because it is:
(A) a hard, brittle inorganic deposit of insoluble calcium phosphate
(B) exclusively composed of active, highly heat-resistant biofilms
(C) a soft, highly hydrated gel-like matrix of pure beta-lactoglobulin
(D) a highly concentrated liquid layer of oxidized and rancid butterfat

2004

230. According to Stokes' Law, what is the effect of doubling the radius of a fat globule on its velocity of separation in a centrifugal field?
(A) the separation velocity remains completely and absolutely unchanged
(B) the separation velocity of the fat globules is exactly halved
(C) the separation velocity increases by a factor of exactly four
(D) the separation velocity increases by a factor of exactly two

****

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2004

199. Biofilms in dairy processing environments exhibit enhanced resilience to physical removal primarily due to:
(A) strong adhesion from the 3D EPS matrix anchored to the surface conditioning layer
(B) the exceptionally high electrical conductivity of the constituent bacterial cell walls
(C) the extremely rapid motility of flagellated planktonic cells within the fluid matrix
(D) their unique biological ability to rapidly cool or freeze the surrounding process fluid

2011

200. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): ATP bioluminescence provides a rapid indication of total surface cleanliness rather than specific microbiological sterility.
Reason (R): The assay measures ATP from both viable microbial cells and residual organic food debris present on the surface.
(A) Both (A) and (R) are true and (R) is the correct explanation of (A).
(B) Both (A) and (R) are true but (R) is not the correct explanation of (A).
(C) (A) is true but (R) is false.
(D) (A) is false but (R) is true.

2001

201. Which specific chemical sanitizer is recognized for its broad-spectrum efficacy, low foaming characteristics, and rapid decomposition into completely harmless byproducts (acetic acid and oxygen)?
(A) sodium hypochlorite
(B) peracetic acid
(C) quaternary ammonium compounds
(D) iodine-based iodophors

2009

202. When calculating the F-value for a commercial sterilization process, a reference temperature is utilized. What is the standard reference temperature for evaluating the destruction of Clostridium botulinum spores?
(A) 100.0°C
(B) 115.5°C
(C) 121.1°C
(D) 135.0°C

2008

203. Scraped-surface heat exchangers mitigate severe fouling in highly viscous dairy products by:
(A) lowering the electrochemical pH of product to prevent protein aggregation
(B) vibrating the entire frame of the heat exchanger at ultrasonic frequencies
(C) using active sub-zero cooling jackets strictly on the exterior housing
(D) using rotating blades to physically scrape product from heat transfer surfaces

2015

204. During UHT sterilization of milk, the phenomenon of "age gelation" is frequently linked to the survival of native milk proteases. Which enzyme is most prominently implicated?
(A) plasmin
(B) lipoprotein lipase
(C) alkaline phosphatase
(D) lysozyme

2008

205. Centrifugal clarifiers are distinct from continuous centrifugal separators in that clarifiers typically possess:
(A) two liquid discharge ports designed for continuous cream and skim separation
(B) one liquid discharge port and an intermittent solid discharging mechanism
(C) the complete and total absence of any internal conical discs whatsoever
(D) an integrated external heating jacket designed to continuously boil milk

2013

206. Bactofugation is widely used in the manufacture of semi-hard and hard cheeses primarily to prevent:
(A) "early blowing" caused by rapid coliform fermentation
(B) "late blowing" defect caused by anaerobic spore-forming Clostridium tyrobutyricum
(C) rapid syneresis of the curd during the cooking process
(D) the growth of psychrotrophic Pseudomonas species during ripening

2001

207. According to Laplace's law, a significant reduction in the radius of a milk fat droplet requires:
(A) increased disruptive energy to overcome high internal opposing pressure
(B) a highly proportional and linear decrease in the applied external pressure
(C) the complete and rapid freezing of the surrounding continuous liquid phase
(D) the total mechanical removal of all dissolved

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insoluble mineral-detergent scale
(C) act as a highly effective, primary antimicrobial killing agent on cells
(D) instantly and completely hydrolyze all structural peptide bonds in soils

2021
175. While assessing plant hygiene, what is the primary benefit of rapid ATP bioluminescence assays over traditional aerobic plate counts?
(A) they provide near-instantaneous feedback on overall surface cleanliness
(B) they can accurately identify the exact bacterial species and strains present
(C) they are significantly cheaper to perform and require no special equipment
(D) they selectively detect only highly pathogenic and toxic bacterial organisms

2012
176. If a thermal process achieves a 5-log reduction of a target pathogen, what percentage of the initial population has been destroyed?
(A) 99.9%
(B) 99.99%
(C) 99.999%
(D) 99.9999%

2014
177. In direct steam infusion systems, localized overheating of milk droplets is prevented by:
(A) allowing the milk to boil continuously and rapidly inside the holding tube
(B) using rotating mechanical scrapers to remove burnt milk from chamber walls
(C) completely freezing the liquid milk prior to entering the processing unit
(D) avoiding contact with hot metal surfaces as milk falls in free-flowing streams or droplets through steam

2008
178. What critical physical property of the UHT-treated product necessitates the use of aseptic packaging immediately downstream of the sterilizer?
(A) the UHT-treated product's extreme physical and structural fragility within pipelines
(B) the highly volatile nature of milk fat components requiring rapid high-pressure sealing
(C) absence of competing microflora, making it highly susceptible to post-contamination spoilage
(D) the immediate onset of extreme and irreversible syneresis upon atmospheric exposure

2008
179. During the initial stages of fouling in a plate heat exchanger, the overall heat transfer coefficient typically:
(A) remains entirely unchanged and stable until total channel blockage occurs
(B) decreases due to the buildup of an insulating protein-mineral layer
(C) increases significantly due to the added surface area of deposited foulant
(D) fluctuates completely randomly depending on the fat content of the fluid

2003
180. Consider the following statements regarding centrifugal bactofugation:
I. Bactofugation strictly targets the selective separation of vegetative coliforms over bacterial spores.
II. The typical temperature for operating a milk bactofuge is between 55°C and 65°C to optimize viscosity.
III. The Bactotherm process completely eliminates the need for thermal treatment by utilizing hyper-centrifugation forces.
IV. A two-phase bactofuge continuously discharges the spore-rich fraction along with some milk solids.
Which of the following represents the INCORRECT combination of statements?
(A) I and III
(B) II and IV
(C) I, II and IV
(D) I, III and IV

NODIA

2024
181. In High-Pressure Homogenization (HPH), the temperature of the fluid increases approximately by how much for every 10 MPa of pressure drop?
(A) 0.5 - 1.0°C
(B) 2.0 - 2.5°C
(C) 5.0 - 6.5°C
(D) 10.0 - 12.0°C

2024
182. Why is a standard two-stage homogenizer often preferred over a single-stage system for processing fluid market milk?
(A) the second stage valve physically and mechanically destroys any remaining spores
(B) the second stage provides all the necessary thermal energy for pasteurization

(D) sublimating simultaneously and directly alongside microscopic water ice crystals

2013

216. In the context of Hurdle Technology, ensuring the microbial stability of intermediate moisture foods usually requires manipulating water activity (a_w) to a range approximately between:
(A) 0.98 and 1.00
(B) 0.60 and 0.85
(C) 0.10 and 0.30
(D) 0.01 and 0.05

2013

217. When developing a shelf-stable dairy-based dessert using hurdle technology, thermal lethality can often be reduced, protecting sensory qualities, by simultaneously:
(A) drastically increasing the ambient storage temperature of packaged desserts
(B) lowering a_w and pH to act synergistically against surviving spores
(C) increasing the final pH values back to complete electrochemical neutrality
(D) maximizing the concentration of dissolved oxygen content within the product

2011

218. The mild antimicrobial effect of carbonation in milk is sometimes strategically combined with cold storage to extend the shelf life of raw milk during transport. This specific combination primarily suppresses:
(A) thermophilic spores
(B) mesophilic lactic acid bacteria
(C) psychrotrophic bacteria
(D) native lipases entirely

2021

219. The "gelation temperature" of whey proteins, the point at which significant irreversible structural networking begins during heating, generally falls in the range of:
(A) 30 - 40°C
(B) 45 - 55°C
(C) 70 - 80°C
(D) 100 - 110°C

2012

220. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): In extrusion texturization of dairy proteins, increasing the feed moisture content typically reduces the mechanical energy input (SME).
Reason (R): High moisture content acts as a plasticizer and lubricant inside the extruder barrel, lowering the bulk viscosity of the melt.
(A) Both (A) and (R) are true and (R) is the correct explanation of (A).
(B) Both (A) and (R) are true but (R) is not the correct explanation of (A).
(C) (A) is true but (R) is false.
(D) (A) is false but (R) is true.

2025

221. When utilizing specific dairy ingredients in bakery products, high-heat Skim Milk Powder (SMP) is often preferred over low-heat SMP for breadmaking because:
(A) high-heat SMP completely and entirely lacks any functional or structural protein content
(B) undenatured whey proteins in low-heat SMP contain free sulfhydryl groups that disrupt the gluten network, depressing loaf volume
(C) low-heat SMP formulations induce rapid, immediate and widespread yeast cell death
(D) high-heat SMP completely prevents any desired Maillard browning from occurring

2007

222. Excessive agitation of a fermented milk product (like yogurt) immediately after the gel has formed will most likely cause:
(A) a significant, highly measurable increase in yogurt gel firmness and stiffness
(B) permanent network damage, resulting in severe and irreversible syneresis
(C) rapid, spontaneous re-coagulation into a completely solid cheese-like block
(D) a sudden, highly unexpected drop in the overall system acidity to pH 7.0

2010

223. Extrusion technology creates "expanded" snack products containing dairy ingredients primarily through which physical mechanism at the die exit?
(A) sudden pressure drop at the die, flashing superheated water to steam and expanding the matrix
(B) the immediate, continuous high-pressure addition of carbonation gas during extrusion
(C) the controlled injection of liquid nitrogen causing the hot matrix to fracture into a foam
(D) high-speed rotating mechanical whipping blades situated directly outside the final die

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(B) reduce the microbial load, serving as a non-thermal pasteurization alternative
(C) instantly dry the liquid milk into a fine, stable powder
(D) convert liquid milk into a highly expanded solid food foam

2012
159. In the context of microfluidizer design, maintaining the temperature of the emulsion during processing is challenging due to:
(A) adiabatic heating from the pressure drop and extreme mechanical shear
(B) endothermic physical reactions occurring during intense particle disruption
(C) the large amount of latent thermodynamic heat generated during evaporation
(D) the necessary continuous addition of liquid nitrogen directly into feed

2015
160. Match the membrane filtration process listed in List I with its typical operating trans-membrane pressure range in List II:
List I: (Membrane Filtration Process)
P. Microfiltration (MF)
Q. Ultrafiltration (UF)
R. Nanofiltration (NF)
S. Reverse Osmosis (RO)
List II: (Operating Pressure Range)
1. 30 - 60 bar
2. 15 - 30 bar
3. 1 - 10 bar
4. 0.1 - 2 bar
(A) P-4, Q-3, R-2, S-1
(B) P-3, Q-4, R-1, S-2
(C) P-1, Q-2, R-3, S-4
(D) P-2, Q-1, R-4, S-3

2014
161. In evaporative concentration, raising the total solids of skim milk from 9% to 45% results in:
(A) a purely linear, highly predictable increase in product dynamic viscosity
(B) complete chemical elimination of the colloidal casein micelle structure
(C) a severe and highly problematic decrease in overall product density
(D) exponential viscosity increase and a shift to non-Newtonian behavior

2022
162. Psychrometric charts are utilized in spray dryer design to accurately determine the:
(A) required mechanical thickness and strength of stainless steel walls
(B) exact droplet size distribution produced by high-pressure atomizers
(C) thermodynamic properties of the air-vapor mixture like enthalpy and humidity
(D) terminal settling velocity of dry milk particles within the tower

2009
163. The primary reason for implementing a two-stage drying process (spray dryer followed by a fluid bed) in milk powder manufacturing is to:
(A) ensure the final milk powder product achieves absolute commercial sterility
(B) gently remove final bound moisture, preventing heat damage and improving structure
(C) increase the surface temperature of the powder to induce controlled caramelization
(D) compress the loose powder matrix into a highly dense, transportable solid block

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2022
164. In the lyophilization of biological dairy cultures, what signifies the end of the primary drying phase?
(A) the immediate physical melting of the frozen product matrix during heating
(B) the sudden, violent boiling of remaining chemically bound water phases
(C) the visual appearance of severe, heat-induced Maillard browning reactions
(D) complete sublimation of ice, indicated by product and shelf temperature equalization

2021
165. The concept of "hurdle homeostasis" in predictive microbiology describes:
(A) microbial energetic efforts to maintain physiological balance against sub-lethal stresses
(B) the biological tendency of cells to die instantly when exposed to a single mild hurdle
(C) the complex chemical process of sterilizing the polymeric packaging materials used
(D) the physical and mechanical separation of different co-existing bacterial species

2006
166. A composite dairy product is formulated with a pH of 5.0 and an a_w of 0.92. This combination restricts pathogenic growth synergistically because:
(A) both physicochemical hurdles independently

ANSWERS

1. (D) The total time in minutes required to destroy a specific number of microbes at a reference temperature
The F-value represents the total thermal process time in minutes required to achieve a specified reduction in a microbial population at a designated reference temperature. It serves as a quantitative measure of the sterilizing efficiency of a thermal process, allowing dairy processors to design safe heat treatments that target specific heat-resistant bacterial endospores like Bacillus stearothermophilus.

2. (C) Heat transfer occurs across a physical stainless steel barrier separating milk and the heating medium
Indirect tubular heating systems achieve thermal treatment by transferring heat energy through physical barriers, typically stainless steel tubes. This design keeps the milk completely separate from the utility heating medium, such as steam or pressurized hot water, which minimizes direct contamination risks while facilitating continuous, efficient, and highly controlled heat exchange required for ultra high temperature processing.

3. (B) Association of denatured beta-lactoglobulin with kappa-casein on micelle surfaces
Pre-heating milk induces the denaturation of whey proteins, particularly beta-lactoglobulin. These denatured proteins interact with kappa-casein on the surfaces of casein micelles via disulfide bond formation. This structural modification creates a protective barrier that prevents the micelles from aggregating under subsequent intense heat treatments, significantly increasing the overall thermal stability of the processed milk system.

4. (D) Unfolded whey proteins cross-linked with casein micelles
Type A fouling in ultra high temperature heat exchangers occurs primarily at temperatures up to one hundred degrees Celsius. It consists mainly of proteinaceous deposits formed when heat denatures globular whey proteins, particularly beta-lactoglobulin. These unfolded proteins then cross-link with casein micelles and deposit on the stainless steel surfaces, creating a soft, voluminous fouling layer.

5. (A) The dynamic viscosity of the continuous milk phase
According to Stokes' law, the terminal settling velocity of a particle in a fluid is directly proportional to the density difference and the square of the particle radius, but inversely proportional to the dynamic viscosity of the continuous phase. Therefore, higher viscosity of the continuous milk phase slows down the centrifugal migration and settling velocity of microbial spores.

6. (C) It sterilizes the spore-rich bactofugate via UHT treatment before recombination with the milk stream
The Bactotherm process optimizes shelf life extension by separating the dense, spore-rich bactofugate fraction using centrifugal force and then sterilizing only this specific stream via direct high-temperature thermal treatment. Recombining the sterilized bactofugate back into the main clarified milk stream prevents significant loss of valuable milk solids while ensuring the finished product is free of endospores.

7. (A) High shear, turbulence, and cavitation forces as fluid exits the first-stage valve
Conventional two-stage homogenization initiates fat globule disruption when milk is forced under high pressure through a narrow gap in the first-stage valve. As the fluid exits the valve, it undergoes extremely rapid changes in velocity and pressure, generating intense shear stress, turbulent micro-vortices, and destructive cavitation that effectively break down large fat globules into sub-micron droplets.

8. (D) Disruption into sub-micelles and subsequent aggregation into new protein networks
High-pressure homogenization exceeding two hundred megapascals applies immense physical forces that destabilize the native structure of casein micelles. These extreme pressures disrupt the hydrophobic and electrostatic interactions that maintain micellar integrity, causing them to dissociate into smaller sub-micelles. These

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44. (A) Gelation and water-holding capacity upon heating
Whey protein concentrates are extensively utilized in processed meat formulations due to their excellent functional properties. Upon heating, these globular proteins unfold and cross-link to form a continuous, cohesive three-dimensional gel network. This heat-induced gelation significantly improves the water-holding capacity, fat retention, and overall textural binding strength of the meat matrix during subsequent thermal processing steps.

45. (B) Irreversible disruption of the gel network causing syneresis
During the manufacturing of stirred yogurt, applying excessive pumping shear post-fermentation severely damages the product quality. High shear forces physically break the delicate acid-induced casein gel network. Because the starter cultures cannot rebuild this network, the damage is irreversible, leading to a permanent loss of viscosity and the release of free whey, a defect known as syneresis.

46. (B) The mechanical work transferred by the drive motor through the screws to the melt
In dairy extrusion processing, the Specific Mechanical Energy quantifies the mechanical energy input delivered per unit mass of the extrudate. This parameter represents the mechanical work transferred by the drive motor through the rotating screws directly into the raw material melt. It serves as a critical indicator of starch gelatinization, protein denaturation, and overall product expansion.

47. (A) React with alkaline cleaners and organic soils to form precipitates
Hard water severely interferes with dairy plant hygiene and cleaning efficiency. The high concentration of dissolved calcium and magnesium ions reacts with alkaline cleaning chemicals and organic milk soils to form insoluble mineral precipitates, commonly known as milkstone. These deposits accumulate on equipment surfaces, reducing heat transfer efficiency and providing a protective anchor for bacterial biofilms.

48. (C) Bacterial secretion of a robust extracellular polymeric substance matrix
During the development of a dairy biofilm, the transition to the irreversible attachment phase is characterized by the bacterial synthesis and secretion of a robust extracellular polymeric substance matrix. This sticky, complex matrix composed of polysaccharides, proteins, and DNA firmly anchors the bacterial cells to the stainless steel surface, shielding them from mechanical flushing and chemical sanitizers.

49. (D) Provides high mechanical scrubbing action at the equipment boundary layer
Maintaining a turbulent flow with a high Reynolds number during cleaning-in-place protocols is critical for effective hygiene. Turbulent flow generates intensive fluid mixing and high-velocity eddies that provide strong mechanical scrubbing action at the equipment boundary layer. This physical force is essential to dislodge, detach, and carry away stubborn organic soils and biofilms from internal pipe surfaces.

50. (D) I, III and IV
Dairy plant sanitizers must be selected based on their chemical and microbiological properties. Hypochlorites are highly effective but sensitive to organic matter, quaternary ammonium compounds provide non-corrosive biofilm control, and ozone decomposes into safe oxygen leaving no chemical residue. However, peracetic acid does not leave toxic residues, and iodophors are acidic, making the other statements completely false.

51. (C) 7.2 minutes
The processing time required to achieve a specific microbial reduction is calculated by multiplying the decimal reduction time, or D-value, by the number of log cycle reductions required. Reducing the spore population from ten to the power of five down to ten to the power of minus one represents a six log reduction, requiring exactly seven point two minutes.

52. (D) Provide rapid heating and cooling profiles, minimizing thermal damage
Direct steam injection systems are highly preferred for heat-sensitive liquid dairy products due to their superior thermal dynamics. By injecting steam directly into the milk stream, these systems achieve instantaneous heating to sterilization temperatures. This is coupled with rapid flash-evaporation cooling, which minimizes the total thermal exposure time and limits chemical damage, protecting delicate flavors and proteins.

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beverage and creates an acidic environment. Furthermore, dissolved carbon dioxide directly penetrates microbial cell membranes, disrupting intracellular homeostasis and exerting toxic physiological effects that inhibit bacterial growth.

18. (C) Diffuse rapidly to the air-water interface and unfold to form a cohesive viscoelastic film
The foaming capacity of whey protein isolates depends on their molecular flexibility and surface-active properties. During mechanical agitation, these proteins diffuse rapidly to the newly created air-water interface, where they quickly unfold to expose hydrophobic segments. This structural rearrangement allows them to form a highly cohesive, viscoelastic protein film that stabilizes air bubbles and prevents foam collapse.

19. (B) Enhancing crust color via Maillard browning and improving moisture absorption capacity
Incorporating skim milk powder into bakery formulations provides critical technological benefits beyond nutritional enhancement. The high lactose and protein content in the powder promotes intensive Maillard browning reactions during baking, yielding a highly desirable golden crust color. Additionally, milk proteins enhance the water-binding and moisture absorption capacity of the dough, improving the overall texture and crumb softness.

20. (D) P-4, Q-3, R-2, S-1
Fermented dairy defects are closely linked to specific technological causes during processing. Insufficient milk solids or heat treatment causes syneresis, while continued starter culture activity during cold storage drives post-acidification. High incubation temperatures lead to rapid, uneven coagulation causing a grainy texture, whereas contamination by exopolysaccharide-producing strains is responsible for the development of undesirable ropiness in fermented products.

21. (A) Positive displacement pumping action that is independent of material friction
Twin-screw extruders provide a distinct advantage in texturizing dairy proteins due to their positive displacement pumping action. The intermeshing design of the dual screws forces the highly viscous dairy melt forward through the barrel regardless of material friction or viscosity changes. This mechanism ensures consistent throughput, uniform shear distribution, and precise control over the protein texturization process.

22. (C) Biological load
In dairy hygiene, the Sinner's Circle defines the four fundamental and highly interdependent parameters required for successful cleaning operations. These four essential factors include chemical action or detergent concentration, mechanical scrubbing action, thermal energy or processing temperature, and contact time. The biological load, while a target of sanitation, is not one of these four core operational parameters.

23. (A) Cell-to-cell communication using signaling molecules to coordinate gene expression
Quorum sensing in dairy biofilms is a sophisticated cell-to-cell communication mechanism used by bacterial populations. Microorganisms produce, release, and detect specific chemical signaling molecules called autoinducers. Once the local bacterial density reaches a critical threshold, these signaling molecules trigger coordinated changes in gene expression, regulating key cooperative activities such as the synthesis of protective extracellular polymeric substances.

24. (D) They selectively degrade complex proteinaceous matrices within biofilms and fouling layers
Bio-detergents containing protease enzymes offer significant advantages in dairy cleaning-in-place protocols. These specialized enzymes selectively hydrolyze and break down the complex proteinaceous soils and extracellular matrices that stabilize biofilms and fouling layers on equipment surfaces. This targeted enzymatic action facilitates the easy removal of stubborn deposits under milder temperature and pH conditions, preserving equipment life.

25. (B) ATP bioluminescence assay
The ATP bioluminescence assay provides a rapid and highly sensitive method for evaluating surface sanitization effectiveness in dairy plants. This technique utilizes the enzymatic luciferin-luciferase reaction, which reacts with residual adenosine triphosphate on clean surfaces to generate light. The intensity of the emitted light is measured, allowing operators to instantly quantify total biological and organic residues.

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maximum velocity in the fluid flow profile. This conservative approach ensures that the fastest-moving fluid element receives the minimum thermal treatment required for sterilization, guaranteeing the safety and microbial stability of the entire continuous product stream.

80. (A) Both A and R are true and R is the correct explanation of A.
Modern continuous dairy processing plants have widely adopted self desludging centrifugal separators to replace traditional solid wall designs. This technological shift is driven by the operational efficiency of these models, which are engineered to periodically and automatically discharge accumulated solids through peripheral ports, eliminating the need to halt operations for manual cleaning cycles.

81. (D) Direct UHT steam injection up to 130–140°C
In the Bactotherm process, the dense and spore-rich bactofugate phase is subjected to a specialized high-heat treatment to ensure microbial safety. This stream is isolated and processed through direct steam injection, reaching temperatures of 130 to 140 degrees Celsius. This intense thermal treatment sterilizes the bactofugate, which is then safely recombined with the main clarified milk stream.

82. (C) Globule radius and interfacial tension between fat and serum phases
The Laplace pressure represents the internal cohesive pressure that opposes the physical deformation and disruption of a milk fat globule during homogenization. The magnitude of this opposing pressure is governed by the radius of the fat globule and the interfacial tension between the hydrophobic fat phase and the surrounding aqueous milk serum, as defined by classical physical chemistry.

83. (B) Disruption of hydrophobic and electrostatic interactions holding sub-micelles together
Casein micelle disintegration during high-pressure homogenization exceeding two hundred megapascals is driven by physical disruption of non-covalent bonds. The extreme hydrostatic pressures and high shear forces applied in the valve overcome the weak hydrophobic and electrostatic interactions that hold the sub-micellar structures together, causing the micelles to break apart into smaller, highly reactive protein fragments.

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84. (D) Collision of two high-velocity fluid streams directly with each other
The Y-type interaction chamber in microfluidization facilitates highly efficient droplet disruption through a unique hydrodynamic mechanism. The pressurized product stream is divided into two separate micro-channels that are engineered to rejoin at a single point. This design forces two high-velocity fluid streams to collide directly with each other, generating intense shear, impact, and cavitation that breaks down droplets.

85. (A) Electrical charge under an applied direct current
Electrodialysis is a membrane-based separation technology utilized in the dairy industry to demineralize whey. This process employs ion-selective membranes that allow only specific ions to pass. Under the influence of an applied direct current, dissolved mineral ions migrate toward opposing electrodes based on their electrical charge, separating them from uncharged lactose molecules and valuable whey proteins.

86. (C) It increases viscosity by promoting whey protein denaturation and complexation with casein micelles
Applying a severe pre-heating treatment to milk prior to evaporative concentration significantly increases its final viscosity. This thermal step denatures the heat-sensitive globular whey proteins, particularly beta-lactoglobulin, promoting their association and complexation with the kappa-casein on the surface of casein micelles. This structural modification increases physical interactions and flow resistance during subsequent concentration stages.

87. (A) Hottest air meets wettest droplets, maximizing evaporation while minimizing thermal damage to the product
Utilizing a co-current flow configuration in a dairy spray dryer ensures optimal drying dynamics and product quality. In this setup, the hottest drying air directly contacts the wettest atomized milk droplets. This alignment maximizes the initial rate of water evaporation while keeping the droplet temperature low due to evaporative cooling, which minimizes thermal damage to heat-sensitive proteins.

35. (B) Water, lactose, and soluble monovalent salts
Ultrafiltration is a membrane separation process widely used in cheese making to concentrate milk proteins and fat. The membrane pores are sized to retain large molecules, including casein micelles and whey proteins, while allowing smaller, soluble molecules to pass through as permeate. Consequently, the ultrafiltration permeate is composed mainly of water, lactose, and soluble monovalent salts.

36. (D) It shifts the fluid behavior from Newtonian to pseudoplastic flow
Severe evaporative concentration fundamentally alters the rheology of milk by significantly increasing the volume fraction of dispersed proteins and fat. As water is removed, the physical proximity and interactions between casein micelles and fat globules increase. This structural crowding transitions the milk's flow behavior from a simple Newtonian fluid into a non-Newtonian, shear-thinning pseudoplastic flow.

37. (A) The wet-bulb temperature of the drying air
During the constant-rate drying period in a spray dryer, the surface of the atomized milk droplet remains covered with a continuous film of free water. As hot air passes over the droplet, rapid evaporation occurs, which absorbs latent heat. This evaporative cooling effect maintains the droplet surface temperature at approximately the wet-bulb temperature of the drying air.

38. (C) Wettability and dispersibility
Agglomeration of milk powder in spray drying systems is a physical process that binds small, individual powder particles into larger, porous clusters. This open, porous structure facilitates more rapid water penetration when the powder is reconstituted. Consequently, agglomeration significantly enhances the instant properties of the dairy powder, specifically improving its overall wettability, sinkability, and dispersibility in water.

39. (A) Desorption of molecularly bound water
During the secondary drying phase of freeze drying, the bulk of the crystalline ice has already been removed by sublimation. The primary focus of this final stage is the removal of the remaining, non-frozen water molecules that are chemically bound to the dairy solutes. This is achieved by desorption, which requires gradually raising temperatures under high vacuum conditions.

40. (A) I and III
Hurdle technology utilizes multiple synergistic factors to preserve foods. Manipulating water activity directly restricts available water, disrupting microbial homeostasis, while adding reducing agents like ascorbic acid lowers the redox potential, creating anaerobic conditions that inhibit aerobic organisms. However, yeast species can tolerate lower pH values, and sub-lethal stresses require adaptation rather than causing immediate metabolic arrest.

41. (B) Quantifying the combined inhibitory effects of applied hurdles on target pathogens
When formulating shelf-stable composite dairy desserts, predictive microbiology plays a vital role by using mathematical models to simulate microbial behavior. This scientific approach allows processors to quantify the combined, synergistic inhibitory effects of various applied hurdles, such as pH, water activity, and temperature, on target pathogens, ensuring microbial safety without relying solely on trial-and-error shelf-life studies.

42. (C) Shifting the calcium equilibrium causing protein destabilization
Carbonation of milk alters its physical and chemical properties by introducing dissolved carbon dioxide, which forms carbonic acid and lowers the pH. This acidification shifts the mineral equilibrium, causing colloidal calcium phosphate to solubilize out of the casein micelles into the serum phase. This loss of structural calcium leads to progressive protein destabilization and potential coagulation.

43. (D) Emulsifying and fat-binding properties
Sodium caseinate is highly valued in industrial dairy and food formulations due to its unique non-micellar, disordered protein structure. This flexible, amphiphilic molecular conformation allows the proteins to diffuse and orient themselves rapidly at oil-water interfaces during processing. Consequently, sodium caseinate exhibits exceptional emulsifying and fat-binding properties, which stabilizes emulsions and prevents fat phase separation.

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This process increases the temperature and pressure of the secondary vapor, allowing it to be recycled as a heating medium.

62. (B) Volumetric crowding of casein micelles and fat globules upon water removal
Concentrating milk via reverse osmosis at low temperatures significantly increases its viscosity. This rheological change is driven by the physical removal of water molecules, which increases the volume fraction of the dispersed phase. This process leads to intense volumetric crowding of the casein micelles and fat globules, which restricts free molecular movement and increases internal flow resistance.

63. (A) Higher evaporation rate or lower drying air temperature
In dairy spray drying systems, an increase in the relative humidity of the exhaust air is a critical process indicator. This change typically signals a higher rate of water evaporation from the droplets or a decrease in the drying air temperature. Monitoring this parameter is essential to prevent incomplete drying and avoid stickiness or lump formation in the powder.

64. (C) Cold-water wettability by modifying surface hydrophobicity of fat-coated particles
The process of lecithination during the spray drying of whole milk powder is specifically designed to improve its reconstitution behavior in cold water. Natural milk fat on the surface of powder particles is hydrophobic, resisting wetting. Coating these particles with a thin layer of lecithin, an amphiphilic surfactant, alters surface properties, facilitating rapid water penetration and dispersion.

65. (D) Glass transition temperature (T_g') of the freeze-concentrated solute matrix
To prevent structural collapse and loss of porosity during the freeze drying of dairy formulations, the product temperature must be kept strictly below its glass transition temperature. This specific temperature represents the point where the amorphous, freeze-concentrated solute matrix transitions from a rigid glass to a flowing, rubbery state, which would lead to structural collapse and poor solubility.

66. (C) Depletion of microbial energy as the cell maintains homeostasis against multiple stresses
Leistner's hurdle technology concept demonstrates that combining multiple sub-lethal preservative factors can achieve complete microbial stability. When microorganisms are exposed to several stresses simultaneously, they must expend their limited metabolic energy reserves to maintain internal homeostasis against each individual hurdle. This continuous energy depletion exhausts the cells, preventing their growth, replication, and survival in the food product.

67. (B) Humectant to lower water activity without causing crystallization
In the formulation of intermediate moisture dairy products, glycerol is commonly utilized as an effective humectant. Its highly hydrophilic molecular structure allows it to bind free water molecules through hydrogen bonding, successfully lowering the overall water activity of the system. Glycerol achieves this without crystallizing or negatively affecting the smooth, desirable texture of the finished dairy formulation.

68. (D) Storage temperature and the final pH of the product
The antimicrobial effectiveness of dissolved carbon dioxide in carbonated dairy beverages is highly dependent on storage temperature and final pH. Lower temperatures significantly increase the solubility of carbon dioxide in the aqueous phase, while a lower pH maximizes the concentration of carbonic acid and undissociated molecules, which can easily penetrate microbial cell membranes to disrupt internal homeostasis.

69. (A) Highly disordered, amphiphilic structure for rapid orientation at fat-water interfaces
Dairy caseinates perform exceptionally well as stabilizers in meat emulsions because of their highly disordered, flexible, and open molecular structures. Unlike globular proteins, caseinates have distinct hydrophobic and hydrophilic domains that are highly accessible. This amphiphilic nature allows them to rapidly migrate to and orient themselves at the fat-water interfaces, creating a strong viscoelastic film that prevents oil coalescence.

70. (C) II - III - IV - I
The standard manufacturing process for commercial stirred yogurt follows a strict

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53. (A) Blocking the kappa-casein cleavage site normally required by chymosin
Severe thermal treatments like ultra high temperature processing cause the irreversible denaturation of beta-lactoglobulin. This unfolded whey protein binds covalently to kappa-casein via disulfide exchanges, forming a complex on the micelle surface. This protein complex physically blocks the cleavage site normally targeted by the chymosin enzyme during renneting, preventing successful curd formation and coagulation in cheese making.

54. (C) A pre-heating step to denature whey proteins before peak temperatures
To mitigate proteinaceous fouling in ultra high temperature heat exchangers, processors implement a thermal pre-heating step. This pre-heating denatures a high percentage of the heat-sensitive whey proteins under controlled conditions. Once denatured and associated with casein micelles in the bulk fluid, these proteins are less prone to depositing and cross-linking on the extremely hot surfaces of the main heater.

55. (A) The bacteria have a density close to milk and are very small, yielding an extremely low settling velocity
Standard centrifugal clarification faces severe physical limitations in removing bacteria from milk. According to Stokes' law, settling velocity decreases rapidly with smaller particle sizes and narrower density differences. Because vegetative bacterial cells are extremely small and have a physical density very close to that of the continuous milk phase, their resulting sedimentation velocity in the centrifuge is exceptionally low.

56. (D) Continuous loss of milk solids into the heavy bactofugate fraction
Operating a continuous two-phase bactofuge presents a significant technological and economic challenge due to the constant discharge of the heavy bactofugate phase. This discharged stream, which carries the separated bacterial spores, also contains a high concentration of valuable milk proteins and total solids. Consequently, continuous operation leads to a steady loss of highly valuable milk solids unless recovered.

57. (B) Stokes' Law
The prevention of cream separation in homogenized milk is fundamentally governed by Stokes' law. This physical law dictates that the rate of creaming of a dispersed phase is directly proportional to the square of the droplet radius. By reducing the average fat globule diameter below one micrometer, homogenization exponentially decreases the creaming velocity, maintaining a stable emulsion.

58. (C) Inactivate vegetative microbial cells, potentially replacing thermal pasteurization
High-pressure homogenization represents an innovative non-thermal processing technology that goes beyond standard emulsion stabilization. By subjecting fluids to pressures exceeding two hundred megapascals, the intense shear, cavitation, and sudden pressure drops physically rupture cell membranes. This mechanism allows the technology to effectively inactivate vegetative microbial cells, offering a potential non-thermal alternative to traditional pasteurization methods.

59. (D) Rapid pressure drops causing the formation and collapse of vapor bubbles
Cavitation in a microfluidizer is generated by forcing the dairy fluid through highly restricted micro-channels under extreme pressure. This restriction causes an immense increase in fluid velocity and a corresponding rapid drop in localized pressure below the vapor pressure of the liquid. Vapor bubbles form instantly and then violently collapse, generating destructive shockwaves that disrupt fat globules.

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60. (A) Reverse Osmosis, Nanofiltration, Ultrafiltration, Microfiltration
Membrane filtration technologies in dairy processing are categorized based on their structural pore size. Reverse osmosis represents the tightest membrane, retaining all solutes. Nanofiltration has slightly larger pores, allowing only monovalent ions to pass. Ultrafiltration retains macromolecules like proteins, and microfiltration has the largest pores, retaining suspended particles like fat globules and bacteria while allowing proteins to permeate freely.

61. (B) Entraining low-pressure secondary vapor with motive steam in a thermocompressor
Thermal vapor recompression improves the energy efficiency of falling film evaporators through thermocompression. This system uses a high-pressure nozzle to inject motive steam, which entrains and mixes with low-pressure secondary vapor drawn from the boiling milk.

26. (C) An increase in the processing temperature by 10°C reduces the D-value by 90%
In thermal death kinetics, the Z-value represents the temperature change required to alter the decimal reduction time, or D-value, by a factor of ten. Therefore, a Z-value of ten degrees Celsius indicates that increasing the thermal processing temperature by exactly ten degrees Celsius will reduce the time required to destroy ninety percent of the target spores by ninety percent.

27. (D) High viscosity or suspended particulates that cause rapid fouling
Scraped-surface heat exchangers are specifically selected for thermal processing when dairy fluids exhibit high viscosity or contain suspended particulates. These conditions typically cause rapid fouling in plate or tubular systems. The continuous action of internal scraping blades constantly removes the boundary layer of product from the heat transfer surface, maintaining high heat transfer rates and preventing product burning.

28. (A) Hydroxymethylfurfural (HMF)
Hydroxymethylfurfural is a highly reliable intrinsic chemical marker used to assess the total heat load applied during ultra high temperature milk processing. This intermediate organic compound is formed through the degradation of hexose sugars and the Maillard browning pathway at elevated temperatures. Measuring its concentration allows quality control analysts to verify processing parameters and monitor thermal product damage.

29. (B) High accumulations of calcium phosphate
Type B fouling in ultra high temperature heat exchangers occurs predominantly at temperatures above one hundred and ten degrees Celsius. Unlike protein-rich Type A fouling, Type B deposits are highly mineralized, consisting mostly of calcium phosphate precipitates. As milk is heated to extreme temperatures, the solubility of calcium phosphate decreases, causing it to crystallize directly onto hot stainless steel surfaces.

30. (C) I
Centrifugal clarifiers are engineered with a single liquid discharge phase specifically to remove solid, high-density impurities from raw milk. Conversely, decreasing the density differential between fat and serum or increasing the milk's viscosity actually reduces separation efficiency according to Stokes' law, as both changes slow down the rate of fat globule migration within the centrifugal field.

31. (A) Spores of Clostridium tyrobutyricum
The primary purpose of cheese milk bactofugation is to remove the high-density endospores of Clostridium tyrobutyricum from the milk supply. These anaerobic spores survive pasteurization and germinate during cheese ripening, fermenting lactate into butyric acid, carbon dioxide, and hydrogen. This fermentation activity causes the severe, late-blowing defect characterized by large cracks and unpleasant off-flavors in hard cheeses.

32. (C) Depletion of free casein micelles needed to coat the newly expanded fat surface
Over-homogenization occurs when excessive energy input drastically increases the surface area of fat globules without a sufficient concentration of emulsifying proteins. When the supply of free casein micelles is depleted, the newly exposed hydrophobic fat surfaces cannot be completely coated. Consequently, the partially covered fat droplets share protein molecules, causing extensive fat clustering and viscosity increases.

33. (D) Extreme shear stress combined with intense cavitation phenomena
High-pressure homogenization initiates rapid microbial cell rupture and localized heating through extreme physical forces. As milk passes through the specialized homogenizing valve under high pressure, it experiences intense shear stress, sudden pressure drops, and destructive cavitation. These combined mechanical forces physically tear the bacterial cell wall, leading to immediate cell lysis and inactivation.

34. (C) Moving mechanical parts inside the homogenization zone
Microfluidization achieves nanometer-scale droplet size reduction in dairy emulsions without employing any moving mechanical parts inside the primary homogenization zone. Instead, the process relies on high-pressure pumps to force fluid streams through static, micro-machined internal channels. This design uses only the kinetic energy of the high-velocity colliding streams to generate the intense shear and impact required for emulsification.

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technological sequence. First, the milk base undergoes homogenization and severe heat treatment to denature proteins. Next, the milk is inoculated and incubated at forty-two degrees until gelation. Finally, the cohesive gel structure is carefully broken by pumping, followed by cooling and packaging at low temperatures.

71. (A) It denatures proteins and gelatinizes starch, creating a cross-linked continuous melt
During the single-screw extrusion of dairy-based snacks, thermomechanical processing deeply alters the molecular structures of the raw ingredients. The combination of intense heat, high shear, and pressure denatures the added dairy proteins and gelatinizes the starch granules. These modified macromolecules then interact and cross-link, forming a cohesive, continuous melt that expands upon exiting the extrusion die.

72. (D) Saponification of lipids into soluble soaps
During the cleaning of dairy processing equipment, sodium hydroxide is utilized as a highly effective alkaline cleaning agent to target fat soils. The strong alkali chemically reacts with the triglycerides present in the milk fat through a process called saponification. This reaction converts insoluble lipids into soluble soaps and glycerol, which are easily washed away by water.

73. (B) Quorum-sensing autoinducers signaling internal nutrient depletion or overcrowding
The dispersion or sloughing phase of a major dairy biofilm represents a coordinated survival mechanism. As the biofilm grows, bacterial cells within the matrix release quorum-sensing signaling molecules called autoinducers. When these molecules reach high concentrations, they signal localized nutrient depletion or overcrowding, triggering the enzymatic release of cells to colonize new areas on the equipment surfaces.

74. (C) Specifically hydrolyze the EPS and proteinaceous matrix of the biofilm
Enzymatic cleaners are highly effective components of dairy cleaning-in-place protocols due to their targeted catalytic activity. These specialized formulations utilize enzymes to specifically hydrolyze the complex extracellular polymeric substances and proteinaceous matrices that anchor biofilms to stainless steel. Breaking down this protective structural barrier allows standard detergents and sanitizers to easily access and destroy the embedded bacteria.

75. (D) Adenosine triphosphate present from both microbial and food residue sources
In ATP bioluminescence swabbing, the measured relative light units are directly proportional to the total concentration of adenosine triphosphate present on the tested surface. This includes ATP from viable microbial cells as well as organic food residues. The assay serves as an immediate, overall indicator of surface cleanliness rather than identifying specific bacterial pathogens.

76. (A) Applying a thermal process to achieve a 12-log reduction of Clostridium botulinum spores
The twelve-D concept is a fundamental safety standard in the thermal sterilization of low-acid foods. It requires applying a heat treatment sufficient to achieve a twelve-decimal reduction in the population of highly heat-resistant Clostridium botulinum spores. This rigorous thermal process ensures that the probability of spore survival in the finished packaged product is extremely low.

77. (B) Turbulent flow induced by corrugated plate patterns
In indirect plate heat exchangers, the flow profile of milk is designed to optimize heat transfer efficiency. The stainless steel plates feature highly engineered corrugated or chevron patterns that disrupt laminar flow. This geometry forces the milk into a highly turbulent flow state at lower velocities, which enhances heat transfer rates and significantly reduces the rate of protein fouling.

78. (B) Isomerization of lactose via the Lobry de Bruyn-Alberda van Ekenstein reaction
The formation of lactulose during the severe thermal treatment of milk is driven by the chemical isomerization of lactose. This reaction occurs through the Lobry de Bruyn-Alberda van Ekenstein mechanism, where the glucose moiety of lactose is converted into fructose under heat. Measuring lactulose concentrations serves as a reliable method to quantify the thermal damage inflicted during processing.

79. (A) Maximum velocity in the flow profile to ensure the fastest particle receives adequate heat
When designing holding tubes for ultra high temperature processing plants, the minimum holding time must be calculated using the

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fragments then rapidly re-associate and aggregate to form entirely new, highly functionalized colloidal protein networks.

9. (B) High shear and impact against channel walls
The Z-type interaction chamber of a microfluidizer forces fluid streams through microscopic channels under extremely high operational pressures. This micro-channel geometry subjects the dairy emulsion to intense shear rates and high-velocity physical impact against the chamber walls. These combined forces generate rapid energy dissipation that reduces the dispersed phase droplet size to nanometer scales, ensuring emulsion stability.

10. (C) A is true but R is false.
Reverse osmosis membranes are highly dense structures that selectively allow only water molecules to pass while retaining dissolved solutes, including minerals, lactose, and proteins. However, reverse osmosis operates primarily on a solution-diffusion transport mechanism rather than physical size exclusion, and the membrane lacks defined pores, meaning the description of micrometer-sized pores is completely incorrect.

11. (D) Age gelation driven by the progressive interaction of protein complexes
Highly concentrated milk products stored at ambient temperatures are susceptible to age gelation, which is a major rheological defect. This phenomenon involves the slow, progressive cross-linking and physical interaction of proteins, particularly denatured whey complexes and casein micelles, to form a continuous three-dimensional network. Over time, this structural network transforms the liquid concentrate into a highly viscous gel.

12. (A) The difference between dry-bulb and wet-bulb temperatures, indicating air humidity
In dairy psychrometry, the wet-bulb depression represents the difference between the dry-bulb temperature and the wet-bulb temperature of the processing air. This parameter serves as a direct indicator of air humidity and the driving force for evaporation. A larger depression indicates drier air, which facilitates more rapid and efficient moisture removal from the atomized milk droplets.

13. (B) High-pressure single-fluid nozzle atomization
High-pressure single-fluid nozzle atomization is highly effective for producing milk powders with elevated bulk density and minimal occluded air. This technique forces the liquid concentrate through a small orifice under high pressure, generating compact, dense droplets without entraining significant volumes of ambient air, which results in powders with superior storage stability and reduced bulk volume.

14. (B) Sublimation of crystalline ice directly into water vapor
During the primary drying stage of freeze drying, the frozen dairy product is subjected to a high vacuum while controlled heat is applied. This environment causes the frozen crystalline ice within the matrix to undergo sublimation, transitioning directly from a solid phase into water vapor without passing through an intermediate liquid state, which perfectly preserves the product's delicate structural matrix.

15. (A) It restricts free water availability required for metabolic reactions and cellular turgor
Lowering the water activity of intermediate moisture dairy foods creates a highly effective hurdle to microbial growth by reducing the amount of free water available. Without sufficient free water, microorganisms cannot maintain crucial cellular turgor pressure or carry out essential biochemical and metabolic reactions, which effectively restricts their growth, replication, and survival in the food matrix.

16. (C) High heat treatment, low water activity from added sugar, and desiccation
The formulation of shelf-stable traditional dairy products like peda relies on a combination of specific preservation hurdles. Intense heat treatment during boiling inactivates vegetative cells and enzymes, while subsequent sugar addition and thermal desiccation significantly reduce the water activity of the product. These parameters work synergistically to prevent microbial spoilage and extend shelf life at room temperature.

17. (D) By forming carbonic acid, lowering pH, and exerting toxic effects on microbial cells
Carbonation extends the shelf life of liquid dairy beverages by dissolving carbon dioxide gas, which reacts with water to form carbonic acid. This process lowers the overall pH of the

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88. (D) Overcome surface tension and submerge into reconstituting water
The functional parameter of sinkability in agglomerated milk powders describes the physical ability of the powder particles to overcome surface tension and submerge quickly into reconstituting water. This property is crucial for rapid and complete reconstitution. Agglomeration enhances sinkability by creating large, porous particle clusters that absorb water rapidly, causing them to sink and dissolve efficiently.

89. (B) Prevent cell damage from intracellular ice formation and osmotic stress
Cryoprotectants are essential additives used during the freeze drying of dairy starter cultures. These compounds protect the viable bacterial cells from physical damage caused by the formation of intracellular ice crystals and severe osmotic stress during freezing. By stabilizing cell membranes and intracellular proteins, cryoprotectants ensure high cell viability and metabolic activity upon subsequent rehydration.

90. (C) P-2, Q-1, R-4, S-3
Hurdle technology parameters target different aspects of microbial physiology. Low water activity restricts the free moisture essential for biological functions, while low pH disrupts transmembrane proton gradients. Added nitrites or nitrates interfere with the energy metabolism of Clostridium species, and maintaining a low redox potential creates anaerobic conditions that inhibit the growth of obligate aerobic microorganisms.

91. (D) Specific fungistatic inhibition of molds and yeasts
When formulating intermediate moisture paneer using hurdle technology, sorbic acid is incorporated to provide a specific preservative function. This organic acid acts as a powerful fungistatic agent, targeting and inhibiting the growth of molds and yeasts. This hurdle is highly critical since these fungal contaminants are capable of surviving under reduced water activity and low pH conditions.

92. (A) Psychrotrophic spoilage bacteria like Pseudomonas species
The addition of pressurized carbon dioxide to raw milk for temporary preservation specifically targets psychrotrophic spoilage bacteria. These organisms, particularly Pseudomonas species, grow at refrigeration temperatures and produce heat-stable enzymes that degrade milk quality. Carbon dioxide dissolves to form carbonic acid, lowering the pH and exerting a direct inhibitory effect on the respiratory enzymes of these Gram-negative bacteria.

93. (B) Unfolding of structures to expose sulfhydryl groups for disulfide cross-linking
Whey proteins exhibit excellent gelation properties upon heating due to a series of structural transitions. Thermal treatment causes these globular proteins to unfold, exposing buried hydrophobic regions and reactive sulfhydryl groups. These highly reactive groups then participate in intermolecular disulfide exchange reactions, forming a stable, covalent three-dimensional network that entraps water and stabilizes the food matrix.

94. (B) Interfere with gluten network formation, resulting in a tender, crumbly texture
When butterfat is utilized as a shortening agent in bakery products, its primary technological function is to interfere with the development of the gluten network. The fat coats the flour particles, physically preventing water from accessing and cross-linking the gluten proteins. This structural disruption results in a highly desirable tender, flaky, and crumbly texture in baked goods.

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95. (A) Severe heat treatment to denature whey proteins and integrate them into the casein gel network
In set-type yogurt manufacturing, raw milk is subjected to severe heat treatment to prevent syneresis. This thermal step denatures whey proteins, enabling them to bind with kappa-casein on the surfaces of casein micelles. This complexation allows the whey proteins to integrate directly into the acid-induced gel network, increasing its water-holding capacity and preventing serum separation.

96. (C) High product expansion ratio and lower bulk density
High specific mechanical energy input during the twin-screw extrusion of whey-fortified snacks significantly enhances product texturization. This energy input drives extensive starch gelatinization and protein denaturation, creating a highly cohesive and viscoelastic melt. Upon

chemically bound water from the dairy matrix. This is achieved after the bulk crystalline ice has been sublimated. The product temperature is gradually increased under high vacuum conditions to promote desorption, reducing the final moisture content of the powder to safe storage levels.

115. (B) Expend energy reserves trying to maintain homeostasis against multiple stresses
In hurdle technology, metabolic exhaustion represents a state where microorganisms can no longer survive or replicate. When subjected to multiple sub-lethal preservation hurdles simultaneously, the bacterial cells are forced to constantly expend their limited metabolic energy reserves to maintain internal homeostasis. This continuous energy depletion exhausts the cells' physiological systems, leading to inactivation or cell death.

116. (D) Reduced water activity (a_w) from added sucrose and hermetic sealing
Sweetened condensed milk achieves its extended shelf life through a combination of preservation techniques. The addition of high concentrations of sucrose significantly increases the osmotic pressure, which lowers the water activity to a level that inhibits the growth of most spoilage bacteria. Hermetic sealing further prevents post-processing contamination and exposure to oxygen.

117. (A) A pleasant effervescence, mild acidity, and masked cooked flavors
Dissolving carbon dioxide in milk leads to the formation of carbonic acid, which imparts a refreshing, mild acidity and pleasant effervescence. This process significantly alters the sensory perception of the milk by masking undesirable cooked or flat flavors that typically arise during high-temperature thermal processing, thereby enhancing the overall palatability and consumer acceptance.

118. (C) Protein concentration, pH, and ionic strength of the surrounding medium
The water-holding capacity of whey protein isolates describes their ability to bind water within a protein gel or matrix. This property is governed by protein conformation, which is highly sensitive to the pH, salt concentration, and ionic strength of the solution. These environmental factors dictate the net charge, protein unfolding, and subsequent macromolecular interactions.

119. (A) Its free sulfhydryl groups undergo disulfide exchange with gluten proteins, disrupting the gluten network
Incorporating whey protein concentrates into bread can weaken the dough structure if the proteins contain active, free sulfhydryl groups. During mixing and baking, these groups participate in disulfide interchange reactions with the gluten-forming proteins, glutenin and gliadin. This exchange prevents proper gluten cross-linking, which reduces gas retention capability and ultimately decreases the final loaf volume.

120. (B) I, III and IV
Post-acidification in cold storage is driven by Lactobacillus bulgaricus rather than Streptococcus thermophilus. Yogurt gelation is driven by acid-induced casein precipitation, not rennet enzymes. Incubation at lower temperatures, such as 37°C, produces a slower, more ordered protein network that is smoother and less prone to syneresis compared to networks formed rapidly at higher temperatures.

121. (B) Thermomechanical energy from external heaters and internal viscous shear
In food extrusion, the conversion of solid raw ingredients into a continuous viscoelastic melt requires substantial energy. This transition is achieved by combining direct thermal energy from external barrel heating elements with mechanical energy generated by the rotating screw. The screw induces high viscous shear and friction, which melts the starch and protein components into a fluid phase.

122. (C) The duration that the active cleaning solution remains in contact with soil
The Sinner's Circle outlines the four interdependent factors that determine cleaning efficiency in sanitation operations. These components include mechanical action, chemical concentration, temperature, and contact time. In this framework, contact time refers specifically to the duration that the chemical cleaning agents remain in direct contact with the soiled surfaces to dissolve, hydrolyze, or loosen deposits.

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dirt, and heavy protein aggregates, accumulates along the outer wall of the centrifuge bowl. Once this space is full, the operator must stop the machine, open the housing, and manually clean out the deposits.

106. (C) It eliminates milk solids loss by capturing spores for intermittent discharge
Operating a bactofuge in a continuous, one-phase discharge mode provides significant economic and process advantages. This design eliminates the continuous loss of valuable milk solids by retaining the separated bacterial spores inside the centrifuge bowl. These captured spores and sediment are then discharged intermittently in highly concentrated, small volumes, maximizing the overall yield of the clarification process.

107. (D) Rapid adsorption of milk proteins to lower interfacial tension and prevent coalescence
The stability of newly formed fat droplets during homogenization is critically dependent upon the rapid adsorption of surface-active milk proteins. Homogenization drastically increases the surface area of the fat phase. Casein micelles and whey proteins must diffuse rapidly to these newly exposed interfaces to lower interfacial tension, forming a protective barrier that prevents droplet coalescence and emulsion breakdown.

108. (A) To counteract adiabatic heat generated (approx. 2-3°C per 10 MPa) during pressure reduction
High-pressure homogenization systems are typically equipped with a cooling mechanism immediately post-valve. This is essential to counteract the adiabatic heating that occurs during the extreme pressure drop. As milk passes through the valve, kinetic energy dissipation increases the fluid temperature by approximately two to three degrees Celsius per ten megapascals, which can cause thermal damage if left uncooled.

109. (B) Shockwaves generated by the implosion of microscopic vapor bubbles
Intense cavitation inside a microfluidization chamber is a major mechanism of fat droplet disruption. As the pressurized fluid passes through the restricted micro-channels, localized pressure drops below the vapor pressure of the liquid, forming microscopic vapor bubbles. When these bubbles move into high-pressure zones, they implode violently, generating powerful localized shockwaves that break down fat globules.

110. (A) II, III and IV
Membrane filtration technologies exhibit distinct operational characteristics. Nanofiltration is used to demineralize whey by permeating monovalent ions while retaining lactose. Microfiltration can concentrate milk proteins without fractionating casein and whey, and reverse osmosis requires much higher trans-membrane pressures than ultrafiltration due to high osmotic pressure. Additionally, cross-flow filtration reduces but does not completely eliminate fouling and pore blockage.

111. (A) To mechanically compress low-pressure vapor into heating steam, lowering steam use
Mechanical vapor recompression systems improve energy efficiency in falling film evaporators by compressing low-pressure secondary vapor using an electrically driven compressor. This mechanical compression increases the temperature and pressure of the vapor, allowing it to be recycled as the heating medium for the evaporator tubes. This process significantly reduces the requirement for fresh, live utility steam.

112. (C) Viscous or concentrated feeds that easily clog small orifices
Rotary atomizers are highly preferred over high-pressure nozzles in spray drying when processing viscous, highly concentrated, or particulate-laden dairy feeds. Because rotary atomizers use centrifugal force generated by a high-speed spinning disc to disperse the liquid, they lack narrow orifices. This design completely eliminates the risk of clogging or uneven spraying, ensuring stable, continuous operations.

113. (D) Amorphous lactose transitioning above its glass transition temperature (T_g)
The stickiness of spray-dried milk powder during production and storage is governed by the physical state of lactose. Spray drying rapid cooling results in lactose in a metastable, amorphous state. If the temperature or humidity rises above the glass transition temperature (T_g), this amorphous lactose absorbs moisture and transitions into a sticky, rubbery state, leading to caking and lump formation.

114. (C) To remove residual bound water by gradually raising temperature under high vacuum
The primary role of the secondary drying phase in freeze drying is to remove the non-frozen,

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exiting the die, the sudden pressure drop causes rapid steam expansion, resulting in a high expansion ratio and low bulk density.

97. (D) Surfactants are depleted or turbulence is insufficient to suspend soils
Soil redeposition occurs during the cleaning cycle of a dairy plant when detached soils settle back onto the equipment surfaces. This phenomenon is typically triggered when surfactants in the cleaning solution are depleted or when the fluid flow lacks sufficient turbulence to keep the removed soil particles suspended, resulting in incomplete cleaning and potential contamination risks.

98. (C) A protective EPS matrix that restricts chemical sanitizer diffusion
Mature biofilms exhibit superior resistance to chemical sanitizers compared to planktonic cells due to their structural characteristics. The embedded bacterial cells are encased within a self-produced, protective extracellular polymeric substance matrix. This dense physical barrier severely restricts the diffusion and penetration of sanitizing chemicals, neutralizing their efficacy before they can reach and destroy the underlying microorganisms.

99. (B) Nitric acid
Nitric acid is the most widely utilized chemical agent in the acid wash phase of dairy cleaning-in-place protocols. This strong inorganic acid is highly effective at dissolving mineral scales, particularly calcium phosphate and milkstone deposits, that accumulate on heated equipment surfaces. Additionally, nitric acid is compatible with stainless steel, helping to passivate the metal surface.

100. (B) II
Peracetic acid is a highly effective sanitizer in dairy processing due to its broad-spectrum efficacy, performance across wide temperatures, and capability to destroy bacterial endospores without leaving toxic residues. Conversely, ozone is a powerful oxidizing agent that leaves no residues, and ATP bioluminescence assays measure total organic contamination rather than directly counting specific viable bacterial colonies.

101. (A) Temperature dependence of the reaction rate constant during inactivation or degradation
The Arrhenius equation is a fundamental mathematical model used in thermal processing of dairy foods. It characterizes the temperature dependence of the reaction rate constant during microbial inactivation or chemical degradation. By calculating the activation energy, this equation allows dairy engineers to predict how processing temperature changes will influence the rates of bacterial destruction and nutrient loss.

102. (C) The vacuum expansion flash vessel
In direct steam injection systems, the vacuum expansion flash vessel is a critical component responsible for product cooling and water balance. When the heated milk enters this low-pressure chamber, the sudden drop in pressure causes instantaneous flash cooling. This process evaporates an amount of water precisely equal to the steam that was injected, preserving the milk's original solids concentration.

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103. (A) Age gelation and development of bitter flavor peptides
The survival of native plasmin or heat-stable bacterial proteases in ultra high temperature processed milk is a major quality concern. During prolonged ambient storage, these active enzymes progressively hydrolyze milk proteins, particularly beta-casein. This proteolytic activity leads to physical destabilization of the protein network, resulting in age gelation and the release of bitter-tasting hydrophobic peptides.

104. (D) Implementing an appropriate pre-heating stabilization step
Implementing an appropriate pre-heating stabilization step is a highly practical operational adjustment to minimize Type A proteinaceous fouling in ultra high temperature plants. This pre-heating step denatures whey proteins under controlled conditions, causing them to associate with casein micelles in the bulk fluid rather than depositing and cross-linking on the extremely hot surfaces of the main heat exchanger.

105. (B) The centrifuge must be stopped, opened, and manually cleaned
In traditional solid-wall clarifiers, there is no automatic mechanism to discharge separated solids during processing. Consequently, the dense particulate matter, including somatic cells,

123. (D) The highly hydrated Extracellular Polymeric Substance (EPS) matrix
Bacterial biofilms are difficult to eradicate from industrial dairy equipment surfaces because of their physical structure. Resident microbes secrete a highly hydrated extracellular polymeric substance matrix composed of proteins, extracellular DNA, and polysaccharides. This barrier shields embedded microorganisms from mechanical shear forces and limits the diffusion of chemical sanitizers, which prevents complete cellular inactivation.

124. (A) Provide turbulent flow and mechanical shearing forces on the soil layer
During clean-in-place operations, a minimum fluid velocity of 1.5 meters per second is required within processing pipelines. This flow rate transition from laminar to turbulent flow ensures high mechanical energy. The resulting turbulence generates high wall shear stress, which is essential to physically detach, lift, and carry away dairy soils and protein deposits from the tube walls.

125. (B) deactivation by organic matter and a potential to corrode stainless steel
Hypochlorite sanitizers are widely used in dairy plants because of their rapid antimicrobial action. However, their efficacy is severely reduced in the presence of organic residues, which consume active chlorine. Furthermore, free chlorine species promote pitting corrosion on stainless steel surfaces, particularly at elevated temperatures or low pH, limiting their continuous contact time during cleaning operations.

126. (B) change tenfold when the processing temperature is altered by 10.5°C
The Z-value is a key parameter in thermal death kinetics, defined as the temperature change required to alter the decimal reduction time by one log cycle. Therefore, a value of 10.5 degrees Celsius indicates that raising or lowering the processing temperature by this specific increment will result in a tenfold decrease or increase in microbial heat resistance.

127. (A) milk is sprayed into a large chamber filled with pressurized steam
Direct ultra-high temperature processing can be executed using steam injection or steam infusion. In an infusion system, the product is sprayed as thin streams or droplets into a pressurized vessel filled with steam, avoiding direct contact with hot metal surfaces. In contrast, steam injection forces pressurized steam directly into the moving liquid milk product stream inside a pipe.

128. (C) the Maillard reaction
The Maillard reaction is a non-enzymatic browning pathway initiated during thermal processing of dairy products. It begins with a nucleophilic attack of the reactive amino group from lysine residues on the electrophilic carbonyl group of reducing sugars like lactose. This complex pathway leads to the formation of melanoidins, which can cause browning, flavor changes, and protein nutritional loss.

129. (D) promoting aggregation of beta-lactoglobulin with casein before peak heating
Pre-heating milk at eighty-five to ninety degrees Celsius denatures whey proteins, predominantly beta-lactoglobulin, forcing them to associate with kappa-casein on the micelle surfaces. This controlled pre-aggregation reduces the availability of free, reactive whey proteins during the subsequent high-temperature heating step. Consequently, this pre-treatment significantly minimizes the deposition and fouling of proteins on heat exchanger surfaces.

130. (C) conditioning layer formation, reversible attachment, irreversible attachment, maturation, dispersion
The development of a bacterial biofilm on dairy contact surfaces follows five distinct sequential phases. First, milk proteins and minerals adsorb to form a conditioning layer. This is followed by the reversible attachment of planktonic cells, which then transitions into strong irreversible attachment. Next, cells multiply and secrete exopolysaccharides during maturation, ending with cell dispersion.

131. (B) specific gravity of the constituents
Centrifugal separation of milk is based on the application of centrifugal force to accelerate the natural sedimentation process. This physical separation is governed by Stokes' Law, which states that components migrate within a centrifugal field according to differences in their specific gravity or density relative to the continuous phase, allowing fat to separate from skim milk.

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surfaces. Additionally, they are relatively non-corrosive to stainless steel and remain highly stable across wide ranges of temperature and pH.

151. (A) the thermal resistance constant (Z-value) of the target microbe
A thermal death time curve plots the heating time required to achieve a specific level of microbial destruction against temperature on a semi-logarithmic scale. The slope of this curve represents the thermal resistance constant, or Z-value. The Z-value specifies the temperature increase needed to reduce the thermal death time tenfold, reflecting microbial heat sensitivity.

152. (D) under a counter-pressure exceeding the saturated vapor pressure of water
In direct steam injection systems, milk is rapidly heated to 140°C. To prevent the milk from boiling inside the holding tube, which would cause severe protein destabilization and localized drying, the system must maintain a high counter-pressure. This pressure must strictly exceed the saturated vapor pressure of water at the corresponding processing temperature.

153. (B) disulfide interchange reactions with kappa-casein
During the thermal processing of milk, heat denatures whey proteins, exposing their internal reactive sulfhydryl groups. These exposed groups, primarily on beta-lactoglobulin, participate in disulfide interchange reactions with the disulfide-containing kappa-casein located on the surface of the casein micelles. This covalent binding modifies micelle properties, reducing downstream gel syneresis and altering rennet coagulation behavior.

154. (C) Using a protein stabilization tube and small plate temperature differences
Indirect UHT heat exchangers utilize specific designs to minimize fouling. Implementing a protein stabilization tube allows denatured whey proteins to aggregate with casein micelles under controlled conditions prior to peak heating. Maintaining small temperature differences between the heating medium and milk reduces local thermal stress, preventing the rapid deposition of calcium phosphate.

155. (D) decrease the settling distance, greatly increasing separation efficiency
Centrifugal separators use a stack of closely-spaced conical discs to enhance separation. These discs divide the liquid flow into thin layers, significantly decreasing the settling distance for fat globules and solid impurities. By shortening this physical distance, particles reach the disc surface much faster, which drastically increases the throughput and overall efficiency of the separation process.

156. (A) spores have higher density, maximizing the density differential in Stokes' equation
Bactofugation is a specialized centrifugal process designed to remove bacterial spores from milk. Spores have a significantly higher density than both vegetative cells and the surrounding milk serum phase. This substantial density difference maximizes the density differential term in Stokes' Law, allowing the centrifuge to selectively separate and discard spores with high efficiency.

157. (B) coalescence
During homogenization, fat globules are disrupted into smaller droplets by intense shear forces. However, these newly created droplets are highly unstable because they lack a protective protein coating. If these droplets collide before casein and whey proteins can adsorb to their interfaces, they immediately merge back together, a phenomenon known as coalescence.

158. (B) reduce the microbial load, serving as a non-thermal pasteurization alternative
High-Pressure Homogenization has emerged as a promising non-thermal technology for processing raw milk. When operated at extremely high pressures, the intense mechanical shear, turbulence, and rapid pressure drop physically damage bacterial cell membranes and walls. This mechanism effectively reduces the microbial load, offering a low-temperature pasteurization alternative that preserves nutritional and sensory qualities.

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159. (A) adiabatic heating from the pressure drop and extreme mechanical shear
Microfluidizers subject emulsions to extreme pressures as they pass through micro-channels. This high-pressure drop generates intense shear, cavitation, and impact forces that reduce droplet sizes. However, these mechanical forces also convert substantial amounts of kinetic energy

penetration. The dissolved gas passes through the lipophilic cell membrane of target microbes. Once inside the cytoplasm, it dissociates into bicarbonate and hydrogen ions, lowering the internal pH and disrupting the transmembrane proton gradient, which ultimately deactivates vital metabolic enzymes.

142. (B) the interfacial area of oil stabilized per unit weight of protein
The Emulsifying Activity Index is a key functional parameter for dairy proteins, quantifying their ability to facilitate emulsion formation. Mathematically, it represents the specific interfacial area of the oil-water interface stabilized per unit mass of the protein. A higher index indicates that less protein is required to coat and stabilize a given volume of oil droplets.

143. (A) foaming capacity and stability
Replacing egg white with whey protein isolate in aerated confections requires the substitute to mimic the native whipping and structural properties. Whey protein isolates must possess exceptional foaming capacity to rapidly incorporate air and high foam stability to prevent liquid drainage or bubble collapse. This ensures the confectionery matrix maintains its desired light and airy texture during processing.

144. (C) the rate of rapid, quiet cooling to prevent gel fracture and halt post-acidification
To prevent syneresis in set yogurt immediately after incubation, controlling the cooling process is essential. The yogurt must undergo rapid, quiet cooling without agitation to halt the metabolic activity of lactic acid cultures and prevent post-acidification. Gentle cooling protects the delicate gel network from fracturing, which preserves structural integrity and prevents the expulsion of whey.

145. (D) It ensures a uniform melt and builds pressure to force material through the die
In a single-screw food extruder, the screw is split into distinct functional zones. The final section, known as the metering zone, has a shallow channel depth. This geometry increases shear and mixing, ensuring a completely uniform and homogeneous melt. It also generates the high head pressure required to force the viscous extrudate through the shaping die.

146. (C) divalent cations (Ca^{2+}, Mg^{2+}) forming insoluble complexes with surfactant
The performance of anionic surfactants in dairy bio-detergents is highly compromised by water hardness. Divalent cations, specifically calcium and magnesium, present in hard water react with the negatively charged polar heads of anionic surfactants. This reaction forms insoluble precipitates, depleting the concentration of active surfactant available for wetting, emulsifying, and suspending dairy soils.

147. (B) sheds viable cells into the milk stream, causing downstream contamination
Biofilm dispersion represents the final stage of the biofilm lifecycle, where sessile cells detach and return to a pinktonic state. From a food safety perspective, this stage is critical because dispersing cells are continuously shed into the flowing milk stream. This phenomenon results in downstream contamination, compromising product quality, reducing shelf life, and spreading potential pathogens.

148. (D) flush out loose residues to minimize chemical load in the alkaline wash
The initial warm water rinse in a clean-in-place sequence is designed to remove loose product residues, soluble sugars, and melted fats from equipment surfaces. By flushing out these easily removable soils, the rinse reduces the overall organic load entering the subsequent alkaline wash step. This preserves the activity and concentration of the primary cleaning chemicals.

149. (A) ATP from viable microbial cells and ATP from somatic cells or raw milk debris
ATP bioluminescence assays are widely used for rapid hygiene monitoring because they measure total adenosine triphosphate on surfaces. However, the assay cannot distinguish the source of the detected ATP. It measures ATP from viable microorganisms, somatic cells naturally present in milk, and raw product debris, indicating overall organic cleanliness rather than specific microbiological contamination.

150. (A) Both (A) and (R) are true and (R) is the correct explanation of (A).
Quaternary ammonium compounds are widely utilized as surface sanitizers in dairy processing plants due to their distinctive properties. They exhibit strong bacteriostatic activity and leave a stable, long-lasting antimicrobial film on sanitized

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132. (D) acid gels (like yogurt) with high firmness and reduced syneresis
High-pressure homogenization of milk causes the disintegration of casein micelles and fat globules, which increases their total surface area. The newly formed fat surfaces are coated with whey proteins and casein fragments. During subsequent fermentation, these modified structures act as active structural nodes within the gel network, improving water-holding capacity, increasing firmness, and minimizing syneresis.

133. (A) boiling point elevation and extreme viscosity increase impeding heat transfer
In falling film evaporators, concentrating milk beyond certain solids levels is constrained by rheological changes. As water is removed, the viscosity of the milk increases exponentially, which reduces the heat transfer coefficient and impedes the flow of the liquid film. Concurrently, the elevated solute concentration raises the boiling point, reducing the overall thermal driving force.

134. (C) induce shear to sweep away deposits, reducing polarization and fouling
Cross-flow membrane filtration is designed so that the feed stream flows parallel or tangentially to the membrane surface rather than directly through it. This high tangential flow velocity generates continuous shear stress across the membrane. This mechanical action sweeps away accumulated solutes and deposits, which minimizes concentration polarization and slows down the rate of membrane fouling.

135. (A) the accumulation of retained solutes forming a concentrated boundary layer
Concentration polarization is a reversible phenomenon occurring in dairy membrane processing. As solvent permeates through the membrane under pressure, retained solutes like proteins and minerals accumulate at the membrane-solution interface. This build-up creates a highly concentrated boundary layer that increases resistance to permeate flow, reduces flux, and can lead to irreversible fouling.

136. (D) higher feed viscosity, deteriorating atomization and yielding larger particles
Lowering the feed temperature before spray drying skim or whole milk increases the viscosity of the liquid concentrate. High viscosity impedes the performance of the atomizer, whether a nozzle or rotary wheel, by restricting efficient liquid breakup. This poor atomization generates larger, irregular droplets, resulting in uneven drying rates and larger finished powder particle sizes.

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137. (B) the glass transition temperature (T_g), depending on moisture content
The physical state of amorphous lactose in spray-dried milk powder is highly sensitive to moisture and temperature. The glass transition temperature represents the critical threshold where amorphous lactose shifts from a rigid, glassy state to a sticky, rubbery state. This temperature decreases as moisture content rises, leading to powder caking, clumping, and crystallization issues.

138. (C) the triple point of water
Freeze-drying is a low-temperature preservation method that relies on sublimation to remove water from a frozen dairy matrix. Sublimation involves the direct phase transition of solid ice into water vapor without melting. To achieve this, the pressure and temperature of the operating environment must be maintained strictly below the triple point of water.

139. (D) predict microbial survival or growth under defined hurdle combinations
Predictive microbiology is a quantitative tool utilized to design and optimize hurdle preservation strategies in food systems. It employs mathematical models to characterize how specific environmental variables, such as temperature, pH, and water activity, influence microbial behavior. This allows processors to accurately predict the survival, growth, or thermal inactivation of target microorganisms.

140. (A) I - IV - II - III
The manufacturing process of agglomerated skim milk powder proceeds in a specific sequence to optimize solubility and structure. First, the fluid milk undergoes pre-heating and pasteurization. Next, it is concentrated using vacuum evaporation. The concentrate is then spray-dried in the primary chamber, and finally, it undergoes fluid bed drying and cooling for agglomeration.

141. (B) It penetrates the membrane, dissociates into acid, and lowers internal pH
Carbon dioxide acts as an effective microbial inhibitor in dairy products through cellular

into heat. This adiabatic heating causes a predictable temperature rise, requiring efficient downstream cooling systems.

160. (A) P-4, Q-3, R-2, S-1
Membrane filtration processes are categorized by their pore size, which dictates the trans-membrane pressure required for operation. Microfiltration uses the largest pores and operates at 0.1 to 2 bar. Ultrafiltration requires 1 to 10 bar, while Nanofiltration operates at 15 to 30 bar. Reverse Osmosis, separating water molecules, requires 30 to 60 bar.

161. (D) exponential viscosity increase and a shift to non-Newtonian behavior
Concentrating skim milk from nine to forty-five percent total solids drastically reduces the distance between casein micelles and whey proteins. This overcrowding leads to strong macromolecular interactions, causing an exponential increase in product viscosity. Additionally, the concentrated milk transitions from a simple Newtonian fluid into a complex, shear-thinning non-Newtonian fluid.

162. (C) thermodynamic properties of the air-vapor mixture like enthalpy and humidity
Psychrometric charts are essential thermodynamic tools in the design and optimization of dairy spray drying systems. They define the relationships between temperature, humidity, enthalpy, and density of the air-vapor mixture. Engineers utilize these charts to calculate energy balances, determine hot air requirements, and optimize drying efficiency by predicting the moisture-carrying capacity of the air.

163. (B) gently remove final bound moisture, preventing heat damage and improving structure
A two-stage drying configuration is standard in milk powder production. The primary spray dryer removes the bulk of the free water, leaving a semi-dry powder. The powder is then transferred to an integrated fluid bed dryer, which gently removes the remaining bound moisture at lower temperatures. This minimizes heat damage, preserves nutritional value, and promotes powder agglomeration.

164. (D) complete sublimation of ice, indicated by product and shelf temperature equalization
In freeze-drying biological cultures, primary drying involves the sublimation of free ice crystals under vacuum. This phase is complete when all unbound ice has sublimated. Thermally, this is indicated when the product temperature rises and equalizes with the shelf heating temperature, signaling that heat is no longer consumed by the latent heat of sublimation.

165. (A) microbial energetic efforts to maintain physiological balance against sub-lethal stresses
Hurdle homeostasis describes the active physiological response of microorganisms when exposed to sub-lethal preservative factors. When confronted with multiple barriers like low pH, salt, or temperature, microbes must consume significant metabolic energy on homeostatic pumps to maintain internal stability. This energy drain exhausts the cells, preventing their growth and causing gradual cell death.

166. (C) sub-lethal pH and a_w levels force the cell to expend excessive metabolic energy on homeostatic pumps, leading to metabolic exhaustion
Combining a pH of 5.0 and a water activity of 0.92 restricts microbial growth synergistically. Each independent hurdle acts as a sub-lethal stress. To survive, the cells must continually pump out excess hydrogen ions and synthesize osmoprotectants. This dual demand rapidly exhausts their limited metabolic energy reserves, preventing cellular division and causing cell death.

167. (A) the chemical dissociation of carbonic acid into bicarbonate and hydrogen ions
When carbon dioxide is dissolved in milk, it reacts chemically with water to form carbonic acid. This weak acid subsequently dissociates into bicarbonate and hydrogen ions, increasing the free hydrogen ion concentration. This dissociation directly drives the reduction in the milk's pH, which alters its sensory profile and provides mild antimicrobial protection during cold storage.

168. (D) forming a 3D network via hydrophobic interactions and disulfide bonds
Heat-induced gelation of globular whey proteins is a multi-step thermodynamic process. Heating above critical denaturation temperatures unfolds the native protein structure, exposing internal hydrophobic amino acids and reactive free sulfhydryl groups. These unfolded proteins aggregate through non-covalent hydrophobic interactions and covalent disulfide cross-linking,

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constructing a stable three-dimensional gel network that traps water.

169. (B) residual Milk Fat Globule Membrane (MFGM) fragments rich in phospholipids
Buttermilk powder is a highly effective emulsifier due to its manufacturing origin. Derived from the churning of cream into butter, it contains high concentrations of milk fat globule membrane fragments. These structures are rich in polar phospholipids and membrane proteins, which act as excellent amphiphilic natural surfactants, stabilizing oil-in-water emulsions more effectively than standard skim milk powder.

170. (B) II
Lower incubation temperatures during yogurt fermentation produce a slower rate of acid development, allowing the casein micelles to organize into a more stable, finer gel network that exhibits high water retention and reduced syneresis. Ropiness is a positive rheological attribute caused by exopolysaccharide-producing starter cultures rather than homogenization defects, making only statement two correct.

171. (D) the intermeshing action of the screws continuously wiping each other
In co-rotating twin-screw food extruders, the raw material is prevented from adhering to and rotating with the screws. This self-cleaning and forward-conveying behavior is driven by the close intermeshing geometry of the screws. The flight of one screw continuously wipes the channel of the adjacent screw, ensuring positive displacement and constant forward material movement.

172. (A) maintaining high fluid velocity and turbulence to scour away soils
The Sinner's Circle designates mechanical action as a primary pillar of sanitizing efficiency. In automated clean-in-place applications, this mechanical force is provided by maintaining high fluid velocities, typically above 1.5 meters per second. This high flow rate induces turbulence, generating high shear stresses on the tube walls that physically scour, lift, and remove soil layers.

173. (B) secreted signaling molecules, such as autoinducers like lactones
Quorum sensing is a key chemical communication mechanism utilized by bacteria to coordinate biofilm behavior and maturation. This system relies on the synthesis, secretion, and detection of small signaling molecules, commonly referred to as autoinducers. When the bacterial density increases, the concentration of these molecules triggers coordinated gene expression responsible for exopolysaccharide production.

174. (B) bind calcium and magnesium to prevent insoluble mineral-detergent scale
Chelating agents, such as ethylenediaminetetraacetic acid, are common additives in dairy cleaning formulations. Their primary role is to bind divalent metal ions, specifically calcium and magnesium, present in hard wash water. By sequestering these ions, chelators prevent them from reacting with detergents to form insoluble mineral precipitates, thereby avoiding the formation of milkstone scale.

175. (A) they provide near-instantaneous feedback on overall surface cleanliness
Sanitation verification in dairy processing requires rapid methods to ensure cleanliness before resuming production. ATP bioluminescence assays are advantageous because they provide near-instantaneous feedback, requiring only minutes compared to the forty-eight hours needed for traditional aerobic plate counts. This rapid response allows operators to re-clean immediately if surface contamination is detected.

176. (C) 99.999%
Logarithmic reductions describe the mathematical efficacy of microbial inactivation during thermal processing. Each log reduction represents a ninety percent decrease in the surviving bacterial population. A five-log reduction reduces the microbial count by one hundred thousand times, which corresponds mathematically to the destruction of exactly 99.999% of the starting target organisms in the food product.

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177. (D) avoiding contact with hot metal surfaces as milk falls in free-flowing streams or droplets through steam
In direct steam infusion UHT systems, milk is sprayed into a pressurized heating chamber filled with steam. The milk falls through the steam in free-flowing thin streams or droplets, absorbing heat directly. Because the liquid does not make contact with hot metal heat transfer walls during

this stage, localized overheating and thermal fouling are significantly minimized.

178. (C) absence of competing microflora, making it highly susceptible to post-contamination spoilage
UHT sterilization destroys all vegetative microorganisms and spores, resulting in a sterile product. However, because there are no competing microflora remaining in the milk, any micro-organism introduced after thermal treatment can rapidly multiply. Therefore, aseptic packaging is critical immediately downstream to prevent post-contamination and preserve the long, shelf-stable life of the sterile milk.

179. (B) decreases due to the buildup of an insulating protein-mineral layer
As fouling begins on plate heat exchangers, proteins and minerals from milk deposit onto the heat transfer walls. This accumulating foulant layer acts as an effective thermal insulator, exhibiting low thermal conductivity compared to the stainless steel. Consequently, the overall heat transfer coefficient decreases, which restricts heat transfer and requires increased heating medium temperatures.

180. (A) I and III
Bactofugation is designed to remove dense bacterial spores rather than coliforms, rendering statement one incorrect. While the bactofuge reduces spore counts, it does not completely eliminate the need for thermal treatment, meaning statement three is also incorrect. Bactofuges typically operate at fifty-five to sixty-five degrees Celsius to optimize density differences and milk viscosity.

181. (B) 2.0 - 2.5°C
In high-pressure homogenization, mechanical energy is converted into thermal energy. As the milk forces through the narrow homogenizing gap, severe shear, friction, and pressure drops occur. This dissipation of physical energy causes a predictable temperature rise in the processed milk of approximately 2.0 to 2.5°C for every 10 MPa of pressure drop applied.

182. (C) second stage breaks up fat clusters formed in the first, preventing creaming
Two-stage homogenization is preferred for fluid milk processing to optimize fat dispersion. In the first stage, high pressure disrupts large fat globules, but the newly formed droplets have a strong tendency to cluster together due to protein interaction. The second stage uses lower pressure to break up these clusters, ensuring uniform dispersion and preventing rapid creaming.

183. (A) stable nano-emulsions for encapsulating bioactive compounds
Microfluidization relies on high-pressure division and collision of fluid streams within an interaction chamber, generating intense shear and impact. These forces are highly uniform, enabling the reduction of fat and lipid droplets to the sub-micron or nanometer scale. Consequently, this technology is ideal for producing stable nano-emulsions used to encapsulate and protect sensitive dairy bioactive compounds.

184. (D) lowest molecular weight of a solute retained at a specified efficiency
Molecular Weight Cut-Off is a key performance specification for ultrafiltration and nanofiltration membranes. It defines the lowest molecular weight of a solute or globular molecule that is retained by the membrane at a specific retention efficiency, typically ninety percent. This metric allows processors to select appropriate membranes for separating proteins from lactose and minerals.

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185. (B) water removal without phase change (latent heat), lowering energy costs
Pre-concentrating milk using reverse osmosis prior to evaporation offers substantial economic advantages. Reverse osmosis removes water molecules from the milk stream using high hydraulic pressure without requiring a phase change from liquid to vapor. Consequently, it avoids the high latent heat of vaporization, which dramatically lowers the thermal energy costs of the overall concentration process.

186. (C) shear-thinning fluid with a yield stress
Highly concentrated whole milk exhibits complex rheological behavior prior to spray drying. The closely packed casein micelles and fat globules create a continuous physical network that resists initial deformation. Therefore, the fluid requires a minimum yield stress to initiate flow. Once flowing, the system exhibits shear-thinning behavior as the macromolecules align under applied shear.

205. (B) one liquid discharge port and an intermittent solid discharging mechanism
Centrifugal clarifiers and standard separation centrifuges serve different operational roles in dairy processing. Clarifiers are designed to remove solid impurities, somatic cells, and dirt from raw milk, featuring a single liquid discharge port for clarified milk. Because they do not split milk into fat phases, they also incorporate mechanisms to collect and periodically discharge accumulated heavy solids.

206. (B) "late blowing" defect caused by anaerobic spore-forming Clostridium tyrobutyricum
Bactofugation is widely used in raw milk preparation for cheese making. Cheese varieties with long ripening times are highly susceptible to late blowing, a defect characterized by excessive gas production and cracking. This gas is produced by the anaerobic fermentation of lactic acid by butyric acid bacteria spores, specifically Clostridium tyrobutyricum, which are efficiently removed via centrifugal bactofugation.

207. (A) increased disruptive energy to overcome high internal opposing pressure
Laplace's Law states that the pressure difference across the interface of a spherical droplet is inversely proportional to its radius. Consequently, as the radius of a milk fat globule decreases during homogenization, the internal opposing pressure rises significantly. Achieving smaller droplet sizes therefore requires progressively higher disruptive energy input to overcome this intense internal Laplace pressure.

208. (C) inducing whey protein unfolding to foster interaction with casein micelles
High-pressure homogenization modifies milk protein structures. The intense shear and turbulence cause globular whey proteins, primarily beta-lactoglobulin, to unfold. This conformational change exposes highly reactive sulfhydryl groups, fostering their interaction and covalent binding with kappa-casein on casein micelle surfaces. During subsequent acidification, this modified structure forms firmer acid gels with improved water retention.

209. (D) chamber design subjects the entire stream to uniform, intense shear and impact
Microfluidization produces emulsions with exceptionally narrow and uniform droplet size distributions. The processed fluid stream is pressurized and divided into two micro-channels before colliding directly within an interaction chamber. This chamber geometry ensures that the entire product volume is subjected to identical, extremely intense shear, cavitation, and impact forces, preventing the formation of large residual droplets.

210. (A) P-4, Q-3, R-1, S-2
CIP cleaning agents are selected for specific functional roles. Sodium hydroxide provides high alkalinity to saponify fats and solubilize proteins. Nitric acid provides acidity to dissolve milkstone and mineral scales. Surfactants lower surface tension to improve soil wetting and penetration. Chelators like EDTA act as metal binders to prevent calcium precipitation and remove water hardness.

211. (B) a gradual decline in permeate flux and altered solute rejection profiles
During ultrafiltration of whey, proteins, lipids, and minerals deposit and accumulate on the membrane surface. This membrane fouling creates an additional structural barrier that increases resistance to hydraulic flow. Consequently, fouling leads to a gradual, continuous decline in permeate flux over operating time and alters the rejection profiles of solutes like lactose and small minerals.

212. (D) maintain a uniform, thin film along the inner tube wall, preventing dry-out and burn-on
In falling film evaporators, distributing the feed liquid uniformly at the top of the heating tubes is critical. This uniform distribution ensures that a continuous, thin liquid film flows down the inner walls of every tube. This flow profile maximizes heat transfer efficiency and prevents local dry-out, which would otherwise cause severe milk browning and burn-on fouling.

213. (A) product temperature during constant rate drying, when surfaces are fully saturated
During the spray drying of milk, the process begins with a constant-rate drying phase. In this initial stage, the surfaces of the atomized droplets are completely saturated with free water. Evaporation occurs rapidly, which cools the droplet surface. Consequently, the actual product temperature closely approximates the wet-bulb temperature of the surrounding hot air throughout this phase.

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196. (D) survival and continued metabolism of Lactobacillus bulgaricus under refrigeration
The defect of post-acidification in yogurt during cold storage is caused by the metabolic activity of starter cultures. Specifically, Lactobacillus bulgaricus exhibits higher acid tolerance and remains metabolically active under refrigeration temperatures. It continues to ferment residual lactose into lactic acid, which causes a continuous drop in pH, resulting in an excessively sour taste and whey syneresis.

197. (A) severe protein degradation and an unacceptably dark, burnt extrudate
Operating a twin-screw food extruder at excessively high barrel temperatures can damage dairy-based feeds. High thermal heat loads denature and degrade functional proteins, destroying their structure and nutritional quality. Concurrently, high temperatures accelerate non-enzymatic browning via the Maillard reaction between dairy proteins and reducing sugars, resulting in a dark, unacceptably burnt final product.

198. (C) cause irreversible bake-on of proteins, making them much harder to remove
Optimizing the temperature of alkaline washes in dairy clean-in-place systems is critical. While heat enhances cleaning chemistry, excessively high temperatures can have adverse effects. High heat denatures and aggregates residual proteins on equipment surfaces, causing them to physically bake onto the stainless steel. This irreversible browning and coagulation creates a stubborn barrier that is difficult to remove.

199. (A) strong adhesion from the 3D EPS matrix anchored to the surface conditioning layer
The physical resilience of biofilms against clean-in-place sanitation is primarily due to their structural adhesion. Microorganisms are embedded within a robust three-dimensional extracellular polymeric substance matrix. This self-secreted matrix is securely anchored to the initial conditioning layer of proteins and minerals on the equipment walls, shielding the bacteria from high shear forces and chemical exposure.

200. (A) Both (A) and (R) are true and (R) is the correct explanation of (A).
ATP bioluminescence assays are powerful rapid verification tools used to evaluate post-sanitation cleanliness. The assay relies on the enzymatic reaction of luciferase to measure total adenosine triphosphate on surfaces. Because ATP is present in all living organisms and organic matter, it detects residues from bacteria, somatic cells, and raw dairy debris, reflecting overall cleanliness.

201. (B) peracetic acid
Peracetic acid is a highly effective chemical sanitizer widely used in the dairy industry. It exhibits broad-spectrum antimicrobial activity against vegetative bacteria, yeasts, molds, and bacterial spores. Furthermore, it is a low-foaming agent that rapidly decomposes after application into completely non-toxic and environmentally friendly byproducts, specifically acetic acid and water, without leaving any harmful residues.

202. (C) 121.1°C
In thermal death calculations, the standard reference temperature utilized globally to evaluate the sterilization of low-acid canned food products is one hundred and twenty-one point one degrees Celsius. This temperature, commonly expressed as two hundred and fifty degrees Fahrenheit, forms the baseline for calculating F-values to ensure the destruction of highly heat-resistant Clostridium botulinum spores.

203. (D) using rotating blades to physically scrape product from heat transfer surfaces
Scraped-surface heat exchangers are utilized to process highly viscous or sticky dairy products like puddings or cheese spreads. These systems contain a central rotating shaft equipped with scraper blades. As the viscous fluid passes through the tube, the rotating blades continuously scrape the product from the heat transfer walls, enhancing heat transfer and preventing localized thermal burning.

204. (A) plasmin
Age gelation is a major physical defect that limits the shelf life of UHT-treated milk during storage. This progressive gelation is driven by residual proteolysis. While high-temperature sterilization inactivates most microorganisms and enzymes, plasmin, a native alkaline milk protease, possesses high heat stability. Its survival allows slow hydrolysis of caseins, causing destabilization and gel network formation.

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187. (D) the ability of wetted particles to separate and distribute evenly in water without lumps
Dispersibility is a critical reconstitutability property of dairy powders. It measures the physical capacity of wetted milk powder particles to detach, separate, and distribute uniformly throughout the water phase under gentle agitation. Excellent dispersibility ensures the powder dissolves completely without forming stable, dry-cored agglomerates or lumps that would compromise product quality and usability.

188. (A) re-wetting fine particles to make them sticky, forming porous clusters upon collision
Agglomeration is a process used to improve the reconstitution properties of spray-dried milk powder. It involves re-wetting fine powder particles, typically in a fluid bed or secondary chamber, to make their surfaces sticky. When these sticky particles collide, they adhere to form large, porous clusters that sink and dissolve rapidly in water.

189. (B) loss of porous cake structure, causing poor rehydration and high residual moisture
During freeze-drying, maintaining temperatures below the glass transition threshold is critical. If the product cake temperature exceeds this transition point, the amorphous sugar-protein matrix transitions to a rubbery state, causing structural collapse. This collapse eliminates the porous channels necessary for vapor escape, resulting in slow drying, high residual moisture, and poor rehydration properties.

190. (B) II and IV
Adding sodium chloride increases osmotic pressure and lowers water activity, but does not significantly reduce redox potential, making statement two incorrect. Sorbate preservatives are weak acids and are highly effective only in their un-dissociated, non-ionic state at low pH levels, making statement four incorrect. All other listed statements accurately describe key hurdle technology mechanisms.

191. (A) unacceptable sensory profiles such as extreme sweetness or saltiness
Intermediate moisture foods achieve preservation by reducing water activity to values between 0.60 and 0.85 using humectants. However, achieving these targets solely through the addition of common humectants like sugars or salts is limited. Excessive humectant concentration results in undesirable sensory profiles, specifically extreme sweetness or saltiness, which severely compromises product palatability.

192. (C) lower wash water pH, inhibiting psychrotrophic spoilage organisms during storage
In cottage cheese manufacturing, carbonating the wash water is a strategic preservation step. The dissolved carbon dioxide forms carbonic acid, which lowers the pH of the wash water. This acidic environment inhibits the growth of common psychrotrophic spoilage bacteria, such as Pseudomonas species, thereby extending the shelf life of the cottage cheese under refrigeration.

193. (D) residual fat competing at interfaces and disrupting the viscoelastic protein film
The foaming properties of whey protein concentrates are highly sensitive to lipid impurities. Residual fat or phospholipids rapidly migrate to the air-water interface during aeration. Because lipids are highly surface-active but cannot form cohesive viscoelastic films, they competitively displace the proteins. This displacement weakens the bubble walls, promoting rapid coalescence and bubble collapse.

194. (C) disordered caseinate structures adsorb rapidly, forming highly stable emulsions
Caseinates are preferred over whey proteins in coffee creamer formulations due to their unique molecular structure. Sodium caseinate has a highly disordered, flexible conformation with distinct hydrophobic and hydrophilic domains. This structural flexibility allows caseinate molecules to adsorb rapidly at oil-water interfaces, creating a highly stable, cohesive steric barrier that prevents creaming and oil separation.

195. (B) improve rheological properties, enhance viscosity, and prevent syneresis
Exopolysaccharide-producing starter cultures are selected for fermented dairy beverages to enhance texture and stability. These bacteria synthesize high-molecular-weight carbohydrate polymers that are secreted into the dairy serum phase. The exopolysaccharides interact with the milk proteins to form a thick, stable network, which increases product viscosity, improves mouthfeel, and effectively prevents whey separation.

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214. (C) particle density compared to the true density of the solid phase
Occluded air refers to the air bubbles entrapped within the interior structure of spray-dried milk powder particles. This parameter is evaluated by measuring the particle density and comparing it to the true density of the solid milk phase. A lower particle density relative to the true solid density indicates high levels of entrapped, occluded air.

215. (A) forming hydrogen bonds to substitute for removed water, maintaining folded structures
Cryoprotectants are added to biological cultures before freeze-drying to protect cells and proteins from denaturation. As water is removed during sublimation, these excipient sugars, such as sucrose or trehalose, form hydrogen bonds with the polar residues on protein surfaces. This molecular substitution replaces the protective water shell, preserving the native folded structure of vital enzymes.

216. (B) 0.60 and 0.85
Intermediate moisture foods are characterized by a water activity range that inhibits most pathogenic bacteria while maintaining a moist, ready-to-eat texture. This shelf-stable state is achieved by adjusting the water activity to values between 0.60 and 0.85. While this range restricts bacterial division, yeast and mold growth must still be controlled using secondary hurdles.

217. (B) lowering a_w and pH to act synergistically against surviving spores
In the design of shelf-stable dairy desserts, optimizing sensory quality requires minimizing intense thermal heat treatments. This is achieved by combining multiple sub-lethal preservation hurdles. Simultaneously reducing the water activity and pH acts synergistically to increase the thermal sensitivity of bacterial spores. This interaction allows safe preservation using milder heat treatments, protecting delicate flavors.

218. (C) psychrotrophic bacteria
Carbonation of raw milk is a preservation strategy utilized during transport and storage. Dissolving carbon dioxide under pressure creates carbonic acid, lowering the milk's pH. When combined with refrigeration, this mild acidity acts synergistically to suppress the growth of aerobic psychrotrophic spoilage bacteria, specifically Pseudomonas species. This technology extends the raw milk holding time before pasteurization.

219. (C) 70 - 80°C
The gelation of globular whey proteins, such as beta-lactoglobulin, requires thermal energy to initiate structural changes. When heated to temperatures within the range of seventy to eighty degrees Celsius, these proteins denature, causing their folded structures to unfold. This unfolding exposes hydrophobic residues and free sulfhydryl groups, enabling covalent cross-linking that establishes a stable gel network.

220. (A) Both (A) and (R) are true and (R) is the correct explanation of (A).
In the extrusion texturization of dairy proteins, the feed moisture content is a key process variable. Water acts as a highly effective plasticizer and lubricant inside the extruder barrel. Raising the moisture content significantly reduces the bulk viscosity of the molten feed, which decreases the internal mechanical friction and lowers the specific mechanical energy input required.

221. (B) undenatured whey proteins in low-heat SMP contain free sulfhydryl groups that disrupt the gluten network, depressing loaf volume
In breadmaking, high-heat skim milk powder is preferred over low-heat variations due to its protein state. Low-heat powders contain undenatured whey proteins that possess active free sulfhydryl groups. During dough mixing, these groups participate in disulfide exchange reactions with gluten, disrupting the gluten network. High-heat treatment denatures these proteins, preventing gluten disruption and protecting loaf volume.

222. (B) permanent network damage, resulting in severe and irreversible syneresis
Agitating fermented yogurt immediately after gelation causes structural damage. The delicate three-dimensional acid-induced protein network relies on weak electrostatic and hydrophobic interactions. Applying high shear or mechanical agitation at this stage fractures the gel network permanently. This structural disruption reduces the water-holding capacity, resulting in severe, irreversible syneresis and whey separation.

NODIA

(D) Pulsed Electric Field – Completely linear log reductions at any field strength

2011

8. All of the following factors influence the D-value of a microorganism during non-thermal processing EXCEPT:
(A) The exact specific heat capacity of the holding tube material
(B) The physiological age and growth phase of the microbial culture
(C) The composition and pH of the food matrix
(D) The inherent genetic resistance of the specific bacterial strain

2024

9. Which model is most appropriate to fit non-linear microbial survivor curves exhibiting both shoulders and tails during non-thermal treatments?
(A) Monod growth model
(B) Weibull model
(C) Gompertz primary model
(D) Michaelis-Menten kinetic model

2023

10. Consider the following statements regarding electromagnetic radiation basics in food materials:
I. Shorter wavelengths possess higher photon energy.
II. Penetration depth is inversely proportional to the frequency of the radiation.
III. Microwaves have higher photon energy than ultraviolet light.
Which of the above statements are correct?
(A) I and III
(B) I and II
(C) II and III
(D) I

2008

11. If a food processor wants to increase the penetration depth of electromagnetic heating while maintaining dielectric interaction, they should apply which frequency adjustment?
(A) Decrease the frequency to radio-frequency levels
(B) Increase the frequency into the infrared spectrum
(C) Increase the frequency into the ultraviolet spectrum
(D) Use high-energy gamma rays to induce dielectric heating

2014

12. What is the primary physical effect when microwave photons interact with liquid water molecules in a dairy product?
(A) Excitation of core electrons leading to immediate cellular ionization
(B) Direct cleavage of covalent oxygen-hydrogen bonds in the molecule
(C) Rapid dipole rotation causing internal friction and heat release
(D) Spontaneous formation of highly reactive oxygen-free radicals

2002

13. How are electromagnetic waves primarily classified when applied in food processing?
(A) By their velocity in a vacuum under standardized conditions
(B) By the rest mass of their corresponding electromagnetic photons
(C) By their capability to be visible or invisible to human eyes
(D) By their ionizing potential and position on the spectrum

2023

14. In comparing microwave heating to radio-frequency (RF) heating in food materials, which statement is accurate?
(A) RF heating systems operate at higher frequencies and shorter wavelengths than microwaves.
(B) Microwave heating relies solely on ionic polarization, whereas RF relies on dipole rotation.
(C) RF heating provides deeper, more uniform penetration in large food blocks than microwaves.
(D) RF heating photons possess significantly higher energy levels than microwave photons.

2003

15. Which characteristic of an electromagnetic wave is least relevant in determining its heating mechanism in a high-moisture food matrix?
(A) Operational wavelength in the medium
(B) Magnetic polarization angle
(C) Applied electromagnetic frequency
(D) Photon energy of the radiation

2010

16. Given that gamma rays possess extremely short wavelengths and high photon energies, one can infer that they interact with food materials primarily by:
(A) Inducing intensive molecular vibration and

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CHAPTER 05

Emerging Technologies for Milk and Milk Products Processing

2007

1. What is the precise definition of the D-value in the kinetics of microbial destruction?

(A) The processing time required to reduce the surviving microbial population by 90 percent

(B) The temperature increase required to reduce the thermal death time by a single log cycle

(C) The holding time required to achieve complete commercial sterility in non-thermal systems

(D) The statistical probability of a single microbial spore surviving the sterilization process

2022

2. Which of the following parameters represents the change in temperature required to alter the D-value by a factor of 10?

(A) F-value

(B) C-value

(C) Z-value

(D) Q10 coefficient

2016

3. In the analysis of non-thermal survivor curves, "tailing" indicates which of the following phenomena?

(A) The presence of a sub-population of cells with higher resistance to treatment

(B) A linear inactivation kinetic behavior where cell death is constant over time

(C) The immediate and complete destruction of cellular matrices during initial seconds

(D) An exponential acceleration in the rate of microbial destruction during processing

2017

4. Identify the correct statement regarding first-order microbial inactivation kinetics.

(A) The overall death rate is independent of the initial concentration of microorganisms.

(B) The survivor curve plotted on a semi-logarithmic scale always yields a convex curve.

(C) The reciprocal of the slope of the semi-logarithmic survivor curve equals the Z-value.

(D) The inactivation rate is directly proportional to the concentration of survivors present.

2017

5. Identify the INCORRECT statement regarding survivor curves in microbial destruction.

(A) A perfectly linear semi-log survivor curve implies uniform resistance among all cells in the population.

(B) The D-value remains constant regardless of the processing medium's pH or water activity.

(C) "Shoulders" on a survivor curve represent an initial delay in microbial death rate.

(D) Clumping of bacterial cells can cause an apparent deviation from first-order destruction kinetics.

2015

6. Which of the following pairs correctly matches the kinetic parameter with its mathematical derivation?

(A) F-value – The negative reciprocal of the slope of the thermal death time curve

(B) Z-value – The y-axis intercept of the plotted semi-logarithmic survivor curve

(C) D-value – The negative reciprocal of the semi-log survivor curve's slope

(D) Lethality rate – The mathematical integral of the F-value divided by the D-value

2002

7. Which pair INCORRECTLY matches the non-thermal processing concept with its typical kinetic anomaly?

(A) High Hydrostatic Pressure – Biphasic survivor curves occurring during long exposure times

(B) Cold Plasma – Shoulder effect due to the accumulation of sublethal cell injuries

(C) UV Light – Tailing effects caused by biological shadowing and aggregate formation

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(B) Radiochromic film dosimeter – Physical measurement of induced radioactive decay
(C) Fricke dosimeter – Oxidation of ferrous ions to ferric ions
(D) Alanine dosimeter – Measurement of stable free radicals via electron spin resonance

2017
26. All of the following are approved sources of ionizing radiation for food processing under international guidelines EXCEPT:
(A) Gamma rays from Cobalt-60
(B) Neutron beams from nuclear fission reactors
(C) X-rays generated from machine sources operated at or below 5 MeV
(D) Electrons generated from machine sources operated at or below 10 MeV

2011
27. Which method is most appropriate for verifying the routine absorbed radiation dose in a commercial food irradiation facility processing pre-packaged cheeses?
(A) Routine placement of chemical dosimeters on the food packaging
(B) Polymerase chain reaction analysis of the remaining microbial DNA
(C) Direct microscopic counting techniques of all surviving bacteria
(D) Continuous monitoring of the internal temperature during treatment

2018
28. If ionizing radiation is applied to whole milk in an oxygen-rich environment, the resulting primary chemical alteration will likely be:
(A) Spontaneous aggregation of structural casein into a very hard curd
(B) Complete and irreversible degradation of all structural carbohydrates
(C) Accelerated lipid oxidation producing aldehydes and off-flavors
(D) The synthetic formation of novel amino acids not found in nature

2017
29. What is the primary cause of protein cross-linking when milk proteins are exposed to high doses of ionizing radiation?
(A) The selective enzymatic cleavage of peptide bonds by radio-activated proteases
(B) The condensation of lactose with amino groups forming irreversible Maillard polymers
(C) The immediate drop in pH causing isoelectric precipitation
(D) The generation of hydroxyl radicals causing the formation of dityrosine bonds

2003
30. Consider the following statements about the effects of ionizing radiation on milk constituents:
I. Vitamin C is highly sensitive and degrades rapidly under irradiation.
II. Fat-soluble vitamins like Vitamin E act as antioxidants and are depleted during irradiation.
III. Milk lipids undergo radiolytic cleavage resulting in volatile hydrocarbons.
IV. Casein micelles are entirely unaffected by radiation doses up to 50 kGy.
V. Irradiation off-flavors in milk are minimized by irradiating in a frozen state.
Which of the above statements are correct?
(A) I, III, IV and V
(B) I, II, III and V
(C) II, III and IV
(D) I, II and IV

2014
31. How does the degradation profile of vitamins in milk during irradiation compare to thermal processing?
(A) Thermal processing destroys fat-soluble vitamins, whereas radiation strictly destroys water-soluble vitamins under standard conditions.
(B) Irradiation causes more severe loss of antioxidant vitamins due to free radical scavenging than thermal pasteurization.
(C) Neither processing method causes any measurable loss of essential vitamins if overall operational exposure times are short.
(D) Both processing methods significantly increase the general bioavailability of dietary Vitamin D by highly equivalent margins.

2021
32. Which constituent of whole milk is least relevant to the development of "irradiation odor" (often described as burnt or metallic) during gamma irradiation?
(A) Unsaturated fatty acids
(B) Sulfur-containing amino acids
(C) Phospholipids
(D) Lactose

2014
33. An inference drawn from the high sensitivity of milk fat to radiolytic oxidation is that:

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sensible heat generation
(B) Triggering rapid dipole rotation of unbound liquid water molecules
(C) Enhancing enzymatic browning reactions in low-acid food systems
(D) Ejecting orbital electrons from atoms to create reactive ions

2022
17. A dairy processing plant replaces a surface-heating infrared system with an ultraviolet system. Based on electromagnetic spectrum properties, which outcome is eliminated?
(A) Direct thermal heating of the product surface
(B) Surface microbial decontamination
(C) Photochemical degradation of certain vitamins
(D) Photon-induced formation of off-flavors in milk fat

2016
18. What is a primary disadvantage of relying on low-frequency electromagnetic radiation for food processing compared to high-frequency radiation?
(A) It causes extensive and highly excessive chemical ionization of the food matrix.
(B) It has an incredibly shallow and limited penetration depth in high-moisture foods.
(C) It requires longer processing times due to lower rates of energy transfer.
(D) It rapidly and severely degrades standard packaging materials used for liquid dairy.

2003
19. What defines the food irradiation process known as radappertization?
(A) The use of high-dose ionizing radiation to achieve commercial sterility
(B) The application of low-dose ionizing radiation to inhibit sprouting in tubers
(C) The selective reduction of non-spore-forming pathogenic bacteria in products
(D) The use of ultraviolet light to pasteurize highly transparent liquid beverages

2023
20. Consider the following statements regarding food irradiation dosimetry and types:
I. Radicidation aims to eliminate specific non-spore-forming pathogens.
II. Radurization extends shelf-life by reducing spoilage microorganisms.
III. Fricke dosimetry is an absolute chemical method used for measuring radiation dose.
IV. The maximum approved dose for radappertization is typically under 1 kGy.
Which of the above statements are correct?
(A) I, II, III and IV
(B) I and IV
(C) II and IV
(D) I, II and III

2010
21. Which unit is the internationally recognized standard for expressing the absorbed dose of ionizing radiation in food?
(A) Sievert (Sv)
(B) Gray (Gy)
(C) Becquerel (Bq)
(D) Roentgen equivalent man (rem)

2011
22. Identify the correct statement about the source of ionizing radiation used in food processing.
(A) Cobalt-60 is a widely used isotope that emits high-energy beta particles for deep penetration.
(B) X-rays used in food processing cause induced radioactivity in high-fat foods.
(C) Electron beams provide shallower penetration compared to gamma rays from Cobalt-60.
(D) Cesium-137 emits alpha particles utilized for surface pasteurization of dairy powders.

2025
23. Identify the INCORRECT statement regarding the application of radurization.
(A) It utilizes doses generally in the range of 0.4 to 10 kGy.
(B) It is designed to extend the shelf-life of foods, analogous to thermal pasteurization.
(C) It targets vegetative spoilage organisms such as Pseudomonas species.
(D) It is synonymous with the complete elimination of all microbial spores.

2003
24. Which pair correctly identifies the irradiation objective with its corresponding typical dose range?
(A) Radappertization – 10 to 50 kGy
(B) Inhibition of sprouting – 10 to 50 kGy
(C) Radicidation – 0.1 to 1.0 kGy
(D) Radurization – 30 to 50 kGy

2016
25. Which pair INCORRECTLY matches the dosimeter type with its mechanism?
(A) Ceric-cerous dosimeter – Electrochemical reduction induced by radiation

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223. (A) sudden pressure drop at the die, flashing superheated water to steam and expanding the matrix
The expansion of extruded dairy snacks is driven by physical changes at the die exit. Inside the extruder, the material is maintained under high pressure and temperature, keeping water in a superheated liquid state. As the melt exits the die, it experiences a sudden pressure drop, causing the superheated water to flash into steam, expanding the matrix.

224. (C) increasing the chemical concentration or extending contact time
The Sinner's Circle defines cleaning efficiency through four balanced parameters: temperature, chemistry, mechanical action, and time. If energy constraints require a reduction in the wash water temperature, this loss of thermal efficiency must be compensated. To maintain equivalent overall cleaning efficacy, operators must increase the chemical detergent concentration or extend the contact time of the wash cycle.

225. (A) P-3, Q-2, R-1, S-4
The bacterial biofilm lifecycle progresses through four distinct structural phases. First, conditioning involves the adsorption of organic milk macromolecules onto bare stainless steel. This is followed by initial adhesion, where planktonic cells reversibly attach. During maturation, cells multiply and secrete a three-dimensional exopolysaccharide matrix. Finally, dispersion is triggered, releasing motile cells due to nutrient depletion.

226. (C) organism B is substantially more heat-resistant than organism A
The D-value is the heating duration required to destroy ninety percent of a microbial population at a constant temperature. If organism A has a D-value of two minutes at 110°C, and organism B has a D-value of five minutes, organism B requires more heating time. This indicates that organism B is substantially more heat-resistant than organism A.

227. (B) contains particulate matter or high viscosity that would block narrow plate channels
Indirect tubular heat exchangers are selected over plate configurations for processing specific dairy products. Plate heat exchangers have narrow channels that are easily blocked by particulate matter or high-viscosity fluids. Tubular designs feature larger, unobstructed flow paths that accommodate particulates and viscous fluids, allowing continuous high-temperature thermal treatment without pressure build-up or channel blockage.

228. (D) the severity of the thermal heat load applied during processing
The formation of lactulose in milk is a chemical marker used to assess thermal processing. Lactulose is an isomer of lactose, synthesized through isomerization catalyzed by heat and alkaline amino groups. Its concentration increases predictably with the duration and temperature of heating, serving as a reliable indicator to evaluate the severity of the thermal heat load during UHT pasteurization.

229. (A) a hard, brittle inorganic deposit of insoluble calcium phosphate
Type B fouling represents a major sanitation challenge in indirect UHT plants. This deposit forms predominantly in the high-temperature sections exceeding 110°C. Unlike protein-rich Type A fouling, Type B is composed of insoluble calcium phosphate and other minerals. This inorganic mineral scale is highly dense, hard, and brittle, requiring strong acid cleaning cycles to achieve complete dissolution.

230. (C) the separation velocity increases by a factor of exactly four
The separation of fat globules in a centrifugal field is mathematically described by Stokes' Law. According to this physical model, the separation velocity of a spherical particle is directly proportional to the square of its radius. Consequently, doubling the radius of a milk fat globule will increase its centrifugal separation velocity by a factor of exactly four.

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NODIA

(A) Irradiating milk under vacuum or inert gas reduces off-flavors.
(B) Skim milk is a much poorer candidate for irradiation than whole milk.
(C) Liquid milk must be aerated before irradiation to avoid off-flavors.
(D) High-dose radappertization is commercially ideal for premium butter.

2002

34. Which technological approach is most effectively used to eliminate or minimize the collateral degradation of milk constituents during ionizing irradiation?
(A) Pre-heating the milk to exactly 90 degrees Celsius immediately prior to the radiation process
(B) Aerating the liquid milk with pure oxygen gas to saturate all available molecular reactive sites
(C) Irradiating the milk in a frozen state at cryogenic temperatures
(D) Increasing the internal moisture content by diluting the milk matrix prior to starting treatment

2011

35. What is the main advantage of using irradiation for sterilizing dairy packaging rather than the dairy product itself?
(A) It prevents radiolytic degradation of the food product.
(B) It alters the packaging's structural permeability to water vapor.
(C) It induces secondary radioactivity in the polymer to kill pathogens.
(D) It bleaches the packaging material, improving visual appeal.

2001

36. In the context of ionizing radiation on proteins, how is "protein fragmentation" defined?
(A) The physical aggregation of proteins via hydrophobic interactions
(B) The fully reversible unfolding of the protein secondary structure
(C) The molecular transformation of alpha-helices into beta-sheet structures
(D) The cleavage of the polypeptide backbone by free radicals

2004

37. Which mechanism primarily generates heat when liquid milk is subjected to microwave processing?
(A) Friction resulting from high-velocity mechanical movement of the liquid against pipe walls
(B) Dipole rotation of water molecules and ionic polarization of dissolved salts
(C) Excitation and subsequent high-energy ejection of tightly bound atomic core electrons
(D) Direct volumetric absorption of photon energy by triglyceride carbon-carbon double bonds

2002

38. The dielectric constant of a food material relates to its ability to:
(A) Conduct high-voltage direct current electrical energy through a medium
(B) Dissipate electrical energy directly into thermal energy within the food
(C) Store electrical energy in an alternating electromagnetic field
(D) Resist structural changes in internal temperature when heated externally

2005

39. Identify the correct statement regarding the dielectric loss factor.
(A) It measures the physical transparency of a food material to incoming electromagnetic waves.
(B) It is a purely theoretical thermodynamic value that has no impact on actual processing.
(C) It decreases down to exactly zero when the liquid water fraction freezes completely into ice.
(D) It measures the efficiency of converting electromagnetic energy into heat.

2021

40. Directions: This question consists of two statements, one labeled as Assertion (A) and the other as Reason (R). Choose the correct option to describe their relationship.
Assertion (A): Microwave heating of frozen dairy products is highly uneven and prone to thermal runaway.
Reason (R): The dielectric loss factor of liquid water is much higher than that of ice, causing thawed regions to absorb energy and heat much faster than the remaining frozen regions.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.

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(D) A is false but R is true.

2013

41. Which pair correctly matches the dielectric property with its physical interpretation?
(A) Dielectric loss factor (varepsilon′) – Refractive index of the medium
(B) Dielectric constant (varepsilon′) – Ability to store electromagnetic energy
(C) Penetration depth – The distance where power decreases to $\frac{1}{2}$ of its surface value
(D) Loss tangent ($\tan\delta$) – The frequency of the applied electromagnetic field

2024

42. Which pair INCORRECTLY matches the microwave heating factor with its effect on processing?
(A) Increased salt concentration – Increases ionic polarization and subsequent energy dissipation rates
(B) Higher frequency – Decreases the electromagnetic penetration depth into the high-moisture food
(C) Increased temperature (in liquid water) – Decreases the dielectric constant of the liquid phase
(D) Ice formation – Drastically increases the dielectric loss factor compared to liquid water

2018

43. All of the following factors heavily influence the dielectric properties of a food product EXCEPT:
(A) Visual color of the food
(B) Total moisture content
(C) Processing temperature
(D) Total salt concentration

2019

44. What is the most appropriate strategy to mitigate the "edge heating effect" in microwave processing of packaged solid foods?
(A) Using perfectly rectangular sharp-cornered packaging profiles
(B) Increasing the microwave power output to absolute maximum levels
(C) Applying alternating cycles of heating and equilibration (pulsing)
(D) Decreasing the physical distance between adjacent product packages

2021

45. In the formulation of a microwaveable cheese sauce, how does the addition of sodium chloride affect the heating rate?
(A) It reduces the heating rate by reflecting the incoming microwaves completely away from the sauce.
(B) It eliminates dipole rotation of water molecules, making them highly inert to microwave fields.
(C) It increases the dielectric constant of the system while simultaneously lowering the loss factor.
(D) It causes localized surface heating due to high ionic polarization, reducing penetration depth.

2015

46. What is the cause of surface burning when thick food materials are subjected to high-intensity far-infrared (FIR) radiation?
(A) FIR radiation penetrates too deeply into the material, causing rapid steam explosions that char surfaces.
(B) FIR radiation ionizes the surface proteins directly, causing an immediate exothermic chain reaction.
(C) FIR has low penetration depth, absorbing and dissipating energy purely at the surface layer.
(D) The high water content of the food reflects FIR back to the emitter, superheating the surrounding air.

NODIA

2019

47. Based on their peak emission wavelengths, how are infrared emitters typically classified in food processing?
(A) High-energy Alpha, Beta, and Gamma radioactive isotope decay emitters
(B) NIR (short), MIR (medium), and FIR (long) wavelength emitters
(C) Uniformly Isotropic and non-uniform Anisotropic source heat emitters
(D) Conductive, Convective, and complex Radiative heat transfer emitters

2023

48. When comparing Near-Infrared (NIR) to Far-Infrared (FIR) heating in food processing, which statement is true?
(A) NIR has a significantly longer wavelength and lower overall penetration depth than FIR in solid foods.
(B) NIR is primarily utilized for deep volumetric internal heating of extremely large solid food masses.
(C) FIR systems consistently operate at a much higher emitter temperature than

corresponding NIR systems.
(D) FIR matches the absorption bands of water better, leading to efficient surface heating.

2014
49. In the application of infrared heating for dairy processing, which food property is least relevant to the efficiency of energy absorption?
(A) Electrical conductivity
(B) Surface emissivity
(C) Moisture content
(D) Color and physical state of the surface

2022
50. Match the infrared terminology in List I with its corresponding characteristic in List II:
List I: (Infrared Terminology)
P. Near-Infrared (NIR)
Q. Far-Infrared (FIR)
R. Emitter Temperature
S. Emissivity
List II: (Characteristics)
1. Matches peak water absorption bands
2. Measure of a material's ability to radiate absorbed energy
3. Extremely high (>1000°C), producing short wavelengths
4. Penetrates slightly deeper into food materials than long waves
(A) P-4, Q-1, R-3, S-2
(B) P-3, Q-1, R-4, S-2
(C) P-1, Q-4, R-2, S-3
(D) P-4, Q-3, R-1, S-2

2024
51. Which mechanism can be effectively eliminated by utilizing infrared radiation in a vacuum for surface dehydration of cheese?
(A) Convective heat losses to air
(B) Latent evaporative cooling effects
(C) Direct radiative heat transfer
(D) Surface-level protein denaturation

2012
52. What is a notable advantage of utilizing infrared surface pasteurization for baked dairy products over conventional hot-air ovens?
(A) It relies entirely on complex air-handling and hot ducting systems during operation.
(B) It ensures perfectly uniform core temperatures without affecting the outer crust structure.
(C) It inherently prevents any Maillard browning reactions from occurring on the surface layer.
(D) It facilitates rapid start-up times and high energy transfer directly to the surface.

2006
53. How is the peak wavelength of an infrared emitter mathematically defined in relation to its absolute temperature?
(A) By Planck's constant
(B) By Wien's displacement law
(C) By the Stefan-Boltzmann law
(D) By Fourier's law of heat conduction

2023
54. Which component of food primarily dictates the absorption spectrum and efficiency of Far-Infrared (FIR) radiation?
(A) Dissolved salts
(B) Ash
(C) Water
(D) Trace vitamins

2004
55. A ceramic heater element used in food drying is an example of which type of infrared emitter?
(A) High-intensity short-wave emitter
(B) High-frequency microwave magnetron
(C) Ultraviolet gas discharge lamp source
(D) Far-infrared (long-wave) emitter

2010
56. Identify the correct statement regarding ohmic heating of milk.
(A) Heat is generated internally via resistance as AC passes through the milk.
(B) Ohmic heating relies entirely on external hot surfaces to conduct heat into liquid milk.
(C) The generation of heat is strictly dependent on the liquid food's specific gravity.
(D) Ohmic heating strictly utilizes high-voltage direct current to prevent electrolysis.

2021
57. Identify the INCORRECT statement regarding the principles of ohmic heating.
(A) It provides uniform and rapid heating of pumpable multiphase foods.
(B) The heating rate is inversely proportional to the square of the electric field strength.
(C) The electrical conductivity of the food matrix is the most critical parameter.
(D) Alternating current (AC) at frequencies like 50-60 Hz is commonly used to minimize electrode fouling.

2001
58. Which pair correctly identifies the ohmic heating parameter with its dependency?

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2016

75. Which pair correctly matches the ultrasound type with its primary application in the dairy industry?

(A) Low-intensity, high-frequency ultrasound – Non-destructive quality monitoring

(B) Low-intensity, high-frequency ultrasound – Complete inactivation of micro-flora

(C) High-intensity, low-frequency ultrasound – Structural preservation of foam arrays

(D) Mega-Hertz ultrasound – Generation of intense acoustic cavitation for mixing

2002

76. Which pair INCORRECTLY matches the high-intensity ultrasound application with its processing effect in dairy?

(A) Milk homogenization – Reduction of fat globule size via extremely high mechanical shear forces

(B) Enzyme inactivation – Modification of protein tertiary structure via extreme localized thermal hotspots

(C) Crystallization control – Destruction of seed crystals to prevent lactose growth

(D) Degassing – Coalescence and subsequent rapid removal of all dissolved air bubbles from the medium

2010

77. All of the following are recognized effects of high-intensity ultrasound on dairy proteins EXCEPT:

(A) Alteration of surface hydrophobicity

(B) Disruption of casein micelles

(C) Improvement in foaming and emulsifying properties

(D) Complete cleavage into single free amino acids

2024

78. What is the most appropriate explanation for the enhanced crystallization of lactose observed when ultrasound is applied to concentrated whey?

(A) Ultrasound acts as a massive thermal heat source that rapidly evaporates all remaining free water in whey.

(B) Sound waves permanently and irreversibly alter the fundamental chemical formula and structure of lactose.

(C) Acoustic cavitation induces secondary nucleation, accelerating crystallization.

(D) Ultrasound completely dissolves existing crystals, forcing a highly unstable supersaturated state in milk.

2011

79. If high-intensity ultrasound is applied to raw milk to achieve microbial inactivation, which synergistic processing strategy is most commonly paired with it (Mano-thermo-sonication) to maximize lethality?

(A) Freezing the raw milk down to exactly -20°C prior to starting sonication

(B) Application of mild heat and mild pressure simultaneously

(C) Saturating the raw milk with pure nitrogen gas under 1 atm of pressure

(D) Adding a highly concentrated solution of sucrose to the liquid milk

2016

80. Consider the following statements regarding high-intensity ultrasound applications:

I. It is highly effective at reducing the size of milk fat globules, comparable to traditional homogenizers.

II. It generally increases the total processing time required for yogurt fermentation by inhibiting starter cultures.

III. It can selectively inactive certain enzymes depending on the applied amplitude and duration.

Which of the above statements are correct?

(A) I and II

(B) II and III

(C) I, II and III

(D) I and III

NODIA

2022

81. Thermosonication can be classified as a hybrid non-thermal/thermal process because it relies on the simultaneous application of:

(A) Heat and high-intensity ultrasound

(B) High hydrostatic pressure and pulsed electric fields

(C) Cold plasma and ionizing radiation

(D) Ohmic heating and infrared drying

2010

82. In comparing ultrasound-assisted homogenization to conventional mechanical valve homogenization, which outcome is typically distinct to ultrasound?

(A) Ultrasound causes massive lipid oxidation, whereas conventional mechanical valves completely prevent any potential oxygen interactions.

(B) Conventional valves significantly decrease the temperature of treated milk, whereas ultrasound cools the overall system even further.

(D) Applied ultrasonic frequency

2011

67. Based on the principles of sonochemistry, one can infer that the generation of free radicals in an aqueous medium during ultrasonic treatment is primarily due to:
(A) The localized extreme temperatures and pressures generated during cavitation bubble collapse
(B) The direct absorption of high-energy electromagnetic photons within the liquid medium
(C) The significant lowering of the liquid food's boiling point under acoustic fields
(D) The rapid and continuous dipole rotation of water molecules under high frequencies

2014

68. Which physical phenomenon can be effectively eliminated as a mechanism of action in purely non-thermal, low-frequency (20 kHz) ultrasonic processing of milk?
(A) High-velocity localized acoustic micro-streaming currents
(B) Severe transient and stable cavitation bubble development
(C) Extreme localized mechanical shear forces in the fluid
(D) Ionizing radiation-induced radiolytic cleavage

2023

69. What is an inherent disadvantage of using high-intensity ultrasound for processing lipid-rich dairy products?
(A) It severely limits and degrades the standard homogenization process of fat globules.
(B) Sonochemical free radicals can accelerate lipid oxidation and off-flavors.
(C) It causes the liquid milk to freeze almost instantly due to rapid adiabatic expansion.
(D) It requires completely sterile boundary conditions to transmit high-intensity waves.

2002

70. Directions: This question consists of two statements, one labeled as Assertion (A) and the other as Reason (R). Choose the correct option to describe their relationship.
Assertion (A): High-intensity ultrasound processing often results in a measurable increase in the temperature of the treated liquid.
Reason (R): Acoustic cavitation bubbles absorb heat from the surrounding liquid as they expand, cooling the bulk fluid.
(A) Both A and R are true and R is the correct explanation of A.
(B) A is true but R is false.
(C) Both A and R are true but R is not the correct explanation of A.
(D) A is false but R is true.

2002

71. The formation, growth, and violent collapse of microscopic gas bubbles in a liquid subjected to ultrasonic waves is known as:
(A) Membrane electroporation
(B) Microscopic ebullition
(C) Fluid sonoluminescence
(D) Acoustic cavitation

2016

72. At what frequency range does high-intensity (power) ultrasound typically operate for food processing applications?
(A) 10 to 15 Hz
(B) 20 to 100 kHz
(C) 2 to 10 MHz
(D) 300 to 500 GHz

2016

73. Identify the correct statement regarding ultrasonic bubble dynamics.
(A) Transient cavitation bubbles persist for thousands of acoustic cycles without any size change.
(B) Stable cavitation bubbles oscillate without violent collapse.
(C) Cavitation bubbles form exclusively in highly degassed liquids under ultra-high pressures.
(D) The violent physical collapse of all cavitation bubbles occurs completely isothermally.

2003

74. Identify the INCORRECT statement regarding the sonochemistry principles in water.
(A) Bubble collapse creates localized hotspots reaching temperatures of several thousand Kelvin.
(B) Sonochemical reactions only occur at bulk liquid temperatures above 100°C.
(C) The extreme conditions during collapse cause the homolytic cleavage of water molecules into hydroxyl and hydrogen radicals.
(D) The extreme pressure changes can physically disrupt microbial cell walls.

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(A) Electrical conductivity – Decreases linearly as the system temperature increases over time
(B) Joule heating rate – Proportional to the applied voltage gradient squared
(C) Thermal run-away – Occurs immediately when the electrical conductivity drops to zero
(D) Cold spots – Always occur in the exact geometric center of the ohmic heating tube

2025
59. Which pair INCORRECTLY matches the component of an ohmic heating system with its function?
(A) Heat exchanger plates – Generate the internal electrical resistance
(B) Electrodes – Deliver electrical current directly into the food stream
(C) Insulated holding tube – Prevents current leakage and ensures safety
(D) Power supply – Provides alternating current at the required voltage

2013
60. Arrange the following steps of ohmic heating fluid flow and processing in the correct sequence:
I. Passage through the electrical field between electrodes
II. Internal heat generation via Joule effect
III. Pumping the liquid dairy product into the heating column
IV. Cooling and packaging of the pasteurized product
Which of the following is the correct sequence?
(A) II, III, I, IV
(B) III, I, II, IV
(C) I, II, III, IV
(D) III, II, I, IV

2011
61. What is the most appropriate reason for using alternating current (AC) rather than direct current (DC) in ohmic heating of food?
(A) To significantly decrease the overall electrical conductivity of the liquid food
(B) To induce rapid and intense molecular dipole rotation in the water molecules
(C) To create intensive and destructive acoustic cavitation bubbles in the liquid
(D) To prevent electrochemical reactions and metal dissolution at electrodes

2019
62. In a particulate food suspension (e.g., fruit chunks in yogurt) processed by ohmic heating, how can a processor ensure the solid particles heat faster than the liquid phase?
(A) By ensuring that the continuous liquid phase has a much higher specific heat capacity
(B) By drastically reducing the applied electrical voltage gradient of the entire system
(C) By formulating the liquid phase to have a lower electrical conductivity than solids
(D) By using high-frequency electromagnetic microwaves instead of standard ohmic heating

2008
63. What is the effect of increasing the salt concentration in whey during ohmic heating?
(A) It decreases electrical conductivity, requiring higher voltages to achieve targeted heating rates.
(B) It increases electrical conductivity, causing faster heating at a given voltage gradient.
(C) It dramatically increases the liquid's dynamic viscosity, causing highly laminar fluid flow.
(D) It completely halts the internal Joule heating effect by creating an electrical Faraday cage.

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2017
64. Ohmic heating is classified technologically as which type of heating method?
(A) Indirect surface heating
(B) Radiative non-thermal processing
(C) Conductive boundary-layer heating
(D) Direct volumetric internal heating

2012
65. In comparing ohmic heating with conventional tubular heat exchangers for high-viscosity dairy fluids, what is a primary distinct difference?
(A) Ohmic heating prevents fouling on hot heat-exchange surfaces.
(B) Ohmic heating relies on large thermal gradients at the walls to transfer heat.
(C) Conventional heating provides more rapid and uniform core heating than ohmic.
(D) Ohmic heating strictly sterilizes the food matrix without any thermal increase.

2011
66. In the application of high-intensity ultrasound for food processing, which property is least relevant to the intensity of acoustic cavitation?
(A) Hydrostatic pressure of the liquid medium
(B) Surface tension of the liquid
(C) Color of the liquid matrix

(C) Ultrasound uses cavitation to disrupt globules, while mechanical valves rely on pressure drops.
(D) Ultrasound completely breaks down lactose molecules, whereas conventional mechanical valve homogenization does not affect sugars.

2007
83. Which characteristic of milk is least relevant in determining the efficiency of microbial inactivation by high-intensity ultrasound?
(A) Ambient room lighting
(B) Microbial species load
(C) Dynamic fluid viscosity
(D) Dissolved gas parameters

2011
84. It can be inferred that ultrasound treatment might accelerate the ripening of certain cheeses because:
(A) It releases large amounts of trapped carbon dioxide gas, which physically softens the internal curd structures.
(B) It rapidly and thoroughly dehydrates the cheese blocks by directly sublimating all bound structural moisture.
(C) It completely sterilizes the cheese matrix, allowing highly spontaneous chemical ripening pathways to occur.
(D) It disrupts starter cultures to release internal ripening enzymes.

2022
85. The application of ultrasound to control ice crystallization during the freezing of ice cream primarily eliminates which undesirable quality defect?
(A) The development of overall product air overrun
(B) The formation of large, coarse ice crystals
(C) The rapid enzymatic hydrolysis of lactose sugars
(D) The physical denaturation of structural whey proteins

2022
86. What is a key processing advantage of High Hydrostatic Pressure (HHP) compared to conventional thermal sterilization?
(A) HHP heavily and rapidly promotes the chemical Maillard browning reaction in liquid dairy products.
(B) HHP effectively destroys all bacterial endspores at standard room temperature under 200 MPa of pressure.
(C) HHP is transmitted uniformly throughout the food matrix regardless of size.
(D) HHP severely and permanently alters the covalent bonds of low-molecular-weight volatile flavor compounds.

2017
87. The Isostatic pressure rule states that:
(A) Pressure acts solely and exclusively on the outer boundary surface of a solid food object in the vessel.
(B) Pressure increases in a strictly linear fashion with the absolute temperature of the processing medium.
(C) The total volume of a compressed gas expands almost infinitely when subjected to high-pressure treatments.
(D) Pressure is transmitted uniformly and instantly, regardless of food shape or size.

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2005
88. Le Chatelier's principle, as applied to High Hydrostatic Pressure, implies that:
(A) Any phenomenon accompanied by a decrease in volume is enhanced by an increase in pressure.
(B) Increased pressure will shift chemical equilibria toward the state with a larger specific volume.
(C) Phase changes under pressure are strictly exothermic.
(D) Microbial membranes become increasingly fluid and unstructured under high pressure.

2025
89. During HHP processing, what physical phenomenon occurs due to adiabatic heating?
(A) The pressure vessel walls undergo rapid and extreme thermodynamic cooling as system pressure rises.
(B) Fluid and food temperatures increase slightly during compression.
(C) Liquid water instantly freezes into structural Ice I at 600 MPa of pressure at standard room temperature.
(D) The treated food product loses structural moisture in direct proportion to the level of applied pressure.

2010
90. Consider the following statements regarding HHP principles:
I. Covalent bonds are heavily disrupted by HHP up to 800 MPa.
II. Non-covalent bonds (hydrogen, hydrophobic)

are highly sensitive to high pressure.
III. The temperature rise during compression for water is approximately 3°C per 100 MPa.
IV. Pressure transmission relies on the low compressibility of liquid media like water.
Which of the above statements are correct?
(A) I, II and IV
(B) II, III and IV
(C) I, III and IV
(D) I and II

2010
91. Identify the INCORRECT statement regarding the thermodynamic effects of HHP.
(A) High hydrostatic pressure decreases the melting point of all solid lipids universally.
(B) HHP causes a reduction in the volume of the system during the compression phase.
(C) The adiabatic temperature increase is fully reversible upon depressurization in an ideal system.
(D) High pressure promotes the unfolding of globular proteins due to water penetrating the hydrophobic core.

2019
92. Which pair correctly identifies the HHP concept with its consequence in food processing?
(A) Isostatic transmission – Highly uneven processing times required for very thick or solid food materials
(B) Adiabatic heating – A massive and sudden thermal temperature spike of 100°C for every 100 MPa applied
(C) Le Chatelier's principle – Disruption of protein quaternary structure due to volume decrease
(D) Low-molecular-weight compound preservation – Completely total destruction of all vitamins and flavor molecules

2022
93. Which pair INCORRECTLY matches the biomolecular bond/interaction with its sensitivity to High Hydrostatic Pressure (up to 800 MPa)?
(A) Hydrophobic interactions – Sensitive, often disrupted
(B) Electrostatic interactions (ionic bonds) – Sensitive, often disrupted
(C) Hydrogen bonds – Variable sensitivity, can be stabilized or disrupted
(D) Covalent bonds – Highly sensitive, readily broken

2017
94. All of the following are typical physical or chemical consequences of HHP application on food systems EXCEPT:
(A) Phase transition shifts (e.g., changes in the freezing point of water)
(B) Denaturation of complex proteins
(C) Substantial generation of radiolytic free radicals
(D) Gelation of polysaccharides or proteins

2005
95. What is the most appropriate pressure-transmitting fluid for a commercial HHP system used for treating packaged foods?
(A) Pure cryogenic liquid nitrogen
(B) Potable water or a water-glycol mix
(C) Concentrated inorganic sulfuric acid
(D) Extremely high-pressure hot steam

2005
96. If raw milk is subjected to HHP treatment (e.g., 600 MPa for 15 minutes), how will the casein micelles primarily respond?
(A) They will aggregate into massive, completely irreversible macro-particles under pressure.
(B) They will remain structurally unaffected due to their inherent thermal stability at high temp.
(C) They will instantly and completely crystallize into highly rigid, sharp geometric shapes.
(D) They will dissociate into sub-micelles as non-covalent bonds are disrupted.

2008
97. The application of HHP to cheese milk causes an increase in cheese yield. What is the primary cause of this effect?
(A) HHP denatures whey proteins to co-precipitate with casein.
(B) The applied vessel pressure permanently traps large volumes of gaseous carbon dioxide in the cheese curd.
(C) HHP synthesizes completely new and complex protein strands directly from the lactose sugars in milk.
(D) The extremely high pressure drastically and permanently reduces the moisture content of the milk matrix.

2014
98. HHP-induced protein gelation of whey proteins is classified as a:
(A) "Hot gelation" driven by covalent bond formation at elevated temperatures
(B) Fully reversible isoelectric precipitation

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under slightly acidic conditions
(C) "Cold set gelation" driven by non-covalent bond disruption
(D) Standard enzymatic coagulation pathways utilizing microbial rennet enzymes

2022
99. When comparing HHP-treated milk to thermally pasteurized milk, which sensory characteristic is typically maintained better in the HHP milk?
(A) The native fresh flavor profile of the raw milk
(B) A strong and highly pronounced cooked off-flavor
(C) An artificially bright, intense white color profile
(D) A heavy, highly caramelized aroma and aftertaste

2014
100. Consider the following statements about HHP applications in dairy:
I. HHP can be used to accelerate cheese ripening by lysing starter culture cells.
II. HHP effectively homogenizes milk fat by breaking globules into nano-emulsions.
III. The color of milk may change slightly (appear more yellowish/translucent) after HHP due to casein micelle disruption.
IV. HHP treatment of whey can produce gels with different rheological properties than heat-induced gels.
V. HHP permanently deactivates all inherently heat-resistant bacterial endospores at 400 MPa.
Which of the above statements are INCORRECT?
(A) II and V
(B) I, III and IV
(C) II, IV and V
(D) I and III

2022
101. An inference drawn from the fact that HHP processing is a batch process in most commercial setups is that:
(A) It is currently completely impossible to apply HHP processing techniques to any type of liquid food product.
(B) Continuous processing of liquids requires specialized valves to handle extreme pressure drops.
(C) The pressure-transmitting fluid must be continuously evaporated and condensed in a cyclic manner during runs.
(D) HHP completely and irreversibly degrades all flexible plastic packaging materials currently used in dairy.

2005
102. Which challenge in cheese manufacturing is effectively eliminated by using HHP-treated milk?
(A) The absolute processing need for milk pre-cooling
(B) The standard requirement for adding starter cultures
(C) The loss of highly nutritious whey proteins into whey
(D) The chemical formation of lactic acid during fermentation

2025
103. What is a significant disadvantage of using HHP to process raw milk for long-term ambient storage?
(A) It induces extremely heavy Maillard browning reactions, turning the finished milk dark brown.
(B) It completely alters the protein structure, rendering the milk totally indigestible for humans.
(C) It creates a highly radioactive and unstable finished product that poses health hazards to consumers.
(D) HHP alone at ambient temperatures cannot reliably destroy bacterial endospores.

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2012
104. What does the term "accelerated cheese ripening" mean in the context of HHP?
(A) Applying pressure to lyse cells, releasing intracellular enzymes into the curd.
(B) Using intensive pressure to physically squeeze excess moisture out of the cheese matrix much faster.
(C) Storing the packaged cheese blocks under a constant pressure of 400 MPa for exactly six months.
(D) Utilizing localized pressure to permanently prevent any mold growth on the outer cheese surface.

2012
105. Arrange the following sequence of events during a typical HHP cycle for packaged liquid milk:
I. Pressure holding time at the target pressure
II. Loading the packaged milk into the vessel and closing the vessel
III. Depressurization and unloading
IV. Pumping of pressure-transmitting fluid to

build up pressure (Compression)

Which of the following represents the correct sequence?

(A) II, IV, I, III
(B) II, I, IV, III
(C) IV, II, I, III
(D) IV, I, II, III

2019

106. In Pulsed Electric Field (PEF) processing, the fundamental mechanism of microbial inactivation is based on:

(A) The severe and sudden reduction of internal pH
(B) Electroporation of the cell membrane
(C) Massive volumetric heat generation causing boiling
(D) The direct emission of sterilizing gamma radiation

2021

107. Identify the correct statement regarding the critical transmembrane potential in PEF.

(A) It is the membrane threshold voltage where pore formation occurs.
(B) It is the high physical pressure required to burst a bacterial cell wall during processing.
(C) It is a theoretical value that strictly applies to large plant cells, not micro-organisms.
(D) It is directly proportional to the mathematical square root of the total processing time.

2010

108. Identify the INCORRECT statement regarding electroporation mechanisms in PEF.

(A) Reversible electroporation allows cells to heal membrane pores after the applied electric field is completely removed.
(B) Irreversible electroporation causes permanent and severe membrane damage, which directly leads to rapid cell death.
(C) Larger cells require higher field strengths than smaller cells.
(D) PEF primarily and selectively targets the hydrophobic lipid bilayer of the functional cell membrane structure.

2008

109. Which pair correctly aligns the PEF term with its underlying physical principle?

(A) Specific energy input – The total volume of gas generated during high-voltage electroporation runs
(B) Pulse width – The physical distance measured between the two opposing conductive electrodes in the chamber
(C) Transmembrane potential – The localized thermal heat gradient across the protective cell wall structure
(D) Electric field strength – Measured in kV/cm, acts as the driving force.

2010

110. Directions: This question consists of two statements, one labeled as Assertion (A) and the other as Reason (R). Choose the correct option to describe their relationship.

Assertion (A): Bacterial spores are highly resistant to Pulsed Electric Field (PEF) processing at ambient temperatures.

Reason (R): Spores lack a large, fluid, functional lipid bilayer cell membrane, which is the primary target for electroporation.

(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2005

111. All of the following are necessary parameters required to calculate the total specific energy input of a PEF treatment EXCEPT:

(A) Applied voltage
(B) The color of the food material
(C) Number of pulses
(D) Capacitance or pulse duration

2012

112. What is the most appropriate range of electric field strengths typically applied for microbial inactivation in liquid foods using PEF?

(A) 0.1 to 1 V/cm
(B) 1 to 5 kV/cm
(C) 10 to 50 kV/cm
(D) 100 to 500 MV/cm

2021

113. If a food processor increases the electrical conductivity of a liquid milk matrix significantly prior to PEF, what will likely occur during processing?

(A) The system experiences higher current draw and potential arcing.
(B) Electroporation efficiency will instantly and automatically double in high-conductivity liquids.
(C) The processed milk will freeze completely solid between the two high-voltage electrodes.

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(D) The critical transmembrane potential of the targeted bacteria will immediately decrease to zero.

2007

114. The cause of localized arcing or sparking inside a PEF treatment chamber is most commonly:
(A) The continuous use of overly purified, zero-conductivity sterile water
(B) Extremely low voltage applications that cannot overcome fluid resistance
(C) Air bubbles present in the liquid passing between the electrodes
(D) The total absence of any living target microorganisms in the processed food

2016

115. Based on cellular morphology, how does PEF classify the susceptibility of different microorganisms?
(A) Yeasts and molds are more susceptible due to their larger size.
(B) Gram-positive bacteria are significantly more susceptible to high electrical field treatment than gram-negative bacteria.
(C) Bacterial spores are inherently the most susceptible of all microbes to irreversible electric field electroporation.
(D) Viruses are highly sensitive and can be easily destroyed by standard pulsed electric fields under typical settings.

2021

116. In comparing co-axial treatment chambers to parallel-plate chambers for continuous flow PEF processing:
(A) Parallel-plate chambers inherently prevent all localized ohmic heating during high-throughput operation.
(B) Co-axial chambers are entirely incapable of processing liquid food products containing water.
(C) Parallel-plate chambers require alternating current, while co-axial chambers require steady direct current.
(D) Parallel-plate chambers offer a more uniform electric field distribution, whereas co-axial chambers provide better fluid flow dynamics.

2018

117. Which parameter of PEF equipment is least relevant to the structural design of the high-voltage pulse generator?
(A) The required peak voltage
(B) The ambient humidity of the storage warehouse
(C) The capacitance of the storage capacitors
(D) The desired pulse wave shape (e.g., square wave or exponential decay)

2008

118. It can be inferred from the need to control the temperature rise during PEF processing of milk that:
(A) PEF relies primarily on thermal inactivation mechanisms to destroy vegetative pathogens.
(B) The electrodes require continuous external heating to maintain active electroporation.
(C) PEF pulses generate unavoidable Joule (ohmic) heating within the treated liquid.
(D) The specific electrical energy input during processing must always be maintained near zero.

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2022

119. Which piece of equipment is effectively eliminated from a pure PEF processing line compared to standard UHT processing?
(A) A high-pressure fluid pump for product transport
(B) A temperature-controlled holding tube section
(C) A sanitary cooling heat exchanger unit
(D) High-capacity steam boilers for direct heating

2018

120. Match the PEF pulse wave shape (List I) with its typical characteristic (List II):

List I: (Pulse Wave Shape)
P. Exponential decay pulse
Q. Square wave pulse
R. Bipolar pulse
S. Oscillatory pulse

List II: (Typical Characteristic)
1. Rapid rise followed by a slow, natural drop in voltage; simple to generate
2. Voltage maintained constantly at peak for a specific duration; highly energy-efficient for lethality
3. Reverses polarity; helps mitigate electrode fouling and electrochemical reactions
4. Fluctuating voltage wave; least efficient for uniform electroporation

(A) P-1, Q-2, R-3, S-4
(B) P-2, Q-1, R-4, S-3
(C) P-1, Q-3, R-2, S-4
(D) P-3, Q-2, R-1, S-4

2002

121. What defines a continuous flow PEF treatment chamber?
(A) A sealed, static pressurized vessel where food ingredients are treated in isolated batches
(B) An electrode assembly through which liquid flows continuously during electrical pulsing
(C) A specialized high-vacuum tube system where dairy foods are dehydrated electrically
(D) A massive insulated tank that rapidly freezes liquid foods using strong electric currents

2010

122. Which material is most commonly utilized for the electrodes in a PEF treatment chamber due to its resistance to electrochemical corrosion and sanitary properties?
(A) High-purity electrolytic copper alloys
(B) Titanium or marine-grade stainless steel
(C) Standard commercial-grade carbon steel
(D) Anodized high-strength commercial aluminum alloys

2002

123. Identify the factual outcome of applying PEF to liquid milk for pasteurization.
(A) It inactivates vegetative pathogens while preserving flavor and nutrition better than thermal pasteurization.
(B) It drastically destabilizes the native colloidal structure of casein micelles, turning milk into an entirely clear liquid.
(C) It induces severe, irreversible loss of water-soluble vitamins at levels comparable to aggressive thermal retorting.
(D) It completely eliminates any requirement for refrigeration or cold chain management of the final packaged product.

2015

124. Identify the correct statement regarding pulse frequency in PEF.
(A) It dictates how fast the liquid moves through the pump.
(B) It refers to the number of electrical pulses delivered per second.
(C) A lower pulse frequency always leads to a higher microbial kill.
(D) It is synonymous with the pulse width.

2024

125. Identify the incorrect statement regarding the application of PEF to liquid foods.
(A) The presence of large air bubbles can cause dielectric breakdown (arcing).
(B) Liquid foods with very high electrical conductivity are difficult to process due to small resistance.
(C) It is highly suitable for heat-sensitive liquid foods like fruit juices and milk.
(D) PEF requires the food to be placed in an alternating magnetic field.

2022

126. Which pair correctly identifies the reactive species generated during cold plasma processing?
(A) Reactive nitrogen species (RNS) – Includes strictly inert atmospheric nitrogen gas (N_2) under high pressure
(B) Ultraviolet photons – Emitted continuously during the thermal recombination of toxic heavy metals
(C) Reactive oxygen species (ROS) – Includes ozone, singlet oxygen, and hydroxyl radicals
(D) Free electrons – Charged subatomic particles responsible for dramatically increasing the pH of the food matrix

2017

127. Which pair incorrectly matches the cold plasma generation method with its description?
(A) Dielectric Barrier Discharge (DBD) – Utilizes an insulating barrier material between electrodes to prevent arc transition
(B) Corona Discharge – Relies on highly uniform parallel flat plates with zero electric field enhancement
(C) Plasma Jet – Discharges a continuous, directed plume of active plasma gas onto a localized target surface
(D) Microwave plasma – Uses high-frequency electromagnetic radiation in the gigahertz range to ionize the gas

2021

128. All of the following are primary mechanisms of microbial inactivation by non-thermal cold plasma EXCEPT:
(A) UV radiation causing DNA dimerization
(B) Etching of the cell surface by reactive species
(C) Lipid peroxidation of the cell membrane by Reactive Oxygen Species (ROS)
(D) Intracellular boiling caused by massive direct heat transfer

2018

129. What is the most appropriate gas mixture used to generate cold plasma for food processing if the goal is to maximize the generation of Reactive Nitrogen Species (RNS)?
(A) Air or Nitrogen/Oxygen mixtures

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(B) Ultra-high purity pressurized Argon
(C) Specialized industrial-grade Helium
(D) Enriched carbon dioxide gas mixtures

2017

130. Arrange the sequence of physical phenomena leading to the creation of cold plasma in a Dielectric Barrier Discharge (DBD) system:
I. Generation of highly reactive secondary species (ROS, RNS)
II. Application of a high-voltage alternating electric field across the gas gap
III. Ionization of gas molecules, producing free electrons and ions
IV. Collision of accelerated electrons with neutral gas molecules
Which of the following is the correct sequence?
(A) II, III, IV, I
(B) II, IV, III, I
(C) IV, II, III, I
(D) III, II, IV, I

2005

131. The primary cause of localized surface etching on microbial cell walls during cold plasma treatment is:
(A) Chemical action of active oxygen species reacting with cell macromolecules
(B) Physical bombardment of cell structures by accelerated heavy atomic nuclei from ionized gas
(C) Intense, localized infrared heat radiation generated directly by the active plasma plume
(D) High-frequency hydrostatic shock waves generated within the surrounding plasma field

2022

132. Cold plasma is physically classified as:
(A) The highly dense, fundamental first state of matter
(B) A purely liquid state containing highly energized atomic ions
(C) A cryogenic state known as the Bose-Einstein condensate
(D) The fourth state of matter, containing an ionized gas

2004

133. In comparing in-package cold plasma treatment with direct plasma jet treatment:
(A) Direct plasma jets can easily process several thousand hermetically sealed packages simultaneously under vacuum.
(B) In-package treatment uses internal gas to generate plasma, eliminating post-process contamination.
(C) In-package treatment relies exclusively on short-wave UV radiation without generating reactive chemical species.
(D) Direct plasma jets are designed exclusively for achieving rapid, deep volumetric heating of liquid foods.

2003

134. Which parameter is least relevant to the efficacy of cold plasma generated in ambient air for surface decontamination?
(A) The humidity/moisture content of the air
(B) The applied voltage and frequency
(C) The color of the external electrodes
(D) The treatment exposure time

NODIA

2015

135. It can be inferred from the shallow penetration depth of reactive plasma species that cold plasma is most suitable for:
(A) Sterilizing the interior core of large, dense cheese blocks
(B) Pasteurizing large volumes of highly opaque, viscous dairy fluids
(C) Enhancing heat transfer in commercial deep-frying applications
(D) Decontaminating surfaces of solid foods and packaging

2013

136. Which physical phase is completely eliminated when a substance transitions beyond its critical temperature and critical pressure into a supercritical state?
(A) The distinction between liquid and gas phases
(B) The physical presence of the solid phase entirely
(C) The functional capacity of the fluid to act as a solvent
(D) The average molecular kinetic energy of the substance

2004

137. What is the primary operational advantage of using supercritical carbon dioxide (SC-CO_2) over organic solvents like hexane for lipid extraction in dairy?
(A) SC-CO_2 exhibits a high level of toxicity, which guarantees complete microbial death.
(B) It leaves no solvent residue in the product after depressurization.

reactions without using any antioxidants

2006
153. Which alternative fat modification process is effectively eliminated or replaced by using SCFE to create specific dairy lipid profiles without generating trans-fats?
(A) High-pressure homogenization
(B) Partial hydrogenation
(C) High-temperature pasteurization
(D) Rotary-atomizer spray drying

2018
154. What is a significant disadvantage of using supercritical fluid extraction for large-scale bulk dairy processing?
(A) It routinely leaves highly toxic chemical residues within the extracted milk fat phase.
(B) It requires high capital investment for high-pressure equipment.
(C) It requires several consecutive weeks of processing time to complete a single standard batch.
(D) It rapidly and completely degrades all fat-soluble vitamins present in the raw fat matrix.

2003
155. Define the term "fractionation" in the context of SCFE processing of anhydrous milk fat.
(A) Separating complex lipid mixtures into fractions of different solubility and physical properties
(B) The complete biochemical cleavage of triglyceride molecules into free fatty acids and glycerol backbones
(C) The intensive mechanical mixing of anhydrous milk fat with various plant-derived vegetable oils
(D) The traditional thermal process of rendering bulk butter to produce high-purity clarified ghee

2016
156. The enzyme lactase, widely used in the dairy industry, is scientifically known as:
(A) α-amylase
(B) Glucose isomerase
(C) β-galactosidase
(D) Lipoprotein lipase

2021
157. Identify the factual source organism commonly used for the commercial production of neutral lactase used in liquid milk processing.
(A) Aspergillus niger
(B) Bacillus subtilis
(C) Streptococcus thermophilus
(D) Kluyveromyces lactis

2004
158. Identify the correct statement regarding the application of transglutaminase in dairy processing.
(A) It strictly hydrolyzes major peptide bonds, rendering the final yogurt product completely liquid.
(B) It is heavily and primarily used to enzymatically convert lactose into sweeter monosaccharides.
(C) It cross-links proteins via covalent bonds between glutamine and lysine residues.
(D) It acts as a specialized biochemical enzyme that synthesizes milk fat from free fatty acids.

2010
159. Identify the incorrect statement regarding commercial lactase application.
(A) It hydrolyzes lactose into glucose and galactose.
(B) It forms highly insoluble polymers that precipitate out of the milk.
(C) It significantly increases the sweetness of the resulting milk.
(D) It reduces the incidence of lactose crystallization in frozen dairy products.

2001
160. Consider the following statements about dairy enzymes:
I. Transglutaminase improves the gel strength and water-holding capacity of yogurt.
II. Lactase derived from Aspergillus species has an optimal pH in the acidic range, making it suitable for whey processing.
III. Cold-active lactases allow for lactose hydrolysis during refrigerated transport.
Which of the above statements are correct?
(A) I and II
(B) II and III
(C) I and III
(D) I, II and III

2009
161. Which pair incorrectly matches the commercial enzyme with its primary effect in dairy?
(A) Glucose oxidase – Coagulation of casein micelles to form hard cheese curd
(B) β-galactosidase – Prevention of lactose crystallization in dulce de leche

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(D) Its low critical temperature makes it suitable for heat-sensitive compounds.

2022

146. Which application is the most appropriate use of Supercritical Fluid Extraction in the dairy industry?

(A) The complete thermal-free pasteurization and microbial sterilization of liquid whole milk

(B) The selective removal of all trace lactose molecules from commercial skim milk powder

(C) Fractionation of anhydrous milk fat to isolate specific triglyceride melting fractions

(D) The enzymatic coagulation of casein proteins during industrial cheddar cheese manufacturing processes

2001

147. A processor wishes to extract highly polar bioactive whey peptides using supercritical CO_2. What conceptual modification must they apply to the SC-CO_2 system to achieve this?

(A) Add a polar co-solvent, such as ethanol or water, to the SC-CO_2

(B) Significantly decrease the system operating pressure to well below 50 bar

(C) Dramatically raise the extraction chamber temperature to 200°C

(D) Continuously filter the CO_2 gas through activated carbon beds beforehand

2023

148. The primary cause for the successful reduction of cholesterol in butter oil using supercritical CO_2 is:

(A) The complete chemical destruction of the sterol ring structure by carbonic acidity within CO_2

(B) The enzymatic conversion of free cholesterol into coprostanol inside the high-pressure extraction vessel

(C) The rapid physical precipitation of cholesterol crystals due to extremely low extraction temperatures

(D) Selective solubility of cholesterol in SC-CO_2 at optimized temperature and pressure

2006

149. The fractionation of milk lipids by SCFE is fundamentally classified as a process driven by:

(A) Complex chemical derivatization and subsequent catalytic hydrolysis of triglycerides

(B) Differences in lipid molecular weight, polarity, and solubility in the dense gas

(C) High-shear mechanical homogenization of the lipids under extreme operating pressures

(D) Centrifugal phase separation of the components based strictly on density differences

2019

150. Match the SCFE application (List I) with its typical operational parameter/mechanism (List II):

List I: (SCFE Application)

P. Cholesterol reduction

Q. Bioactive lipid extraction

R. Anhydrous milk fat fractionation

S. Use of an entrainer

List II: (Operational Parameter/Mechanism)

1. Separation of high-melting from low-melting triglycerides via stepwise depressurization
2. Tuning pressure specifically to target sterol solubility
3. Adding ethanol to extract polar sphingolipids from dairy byproducts
4. Isolating high-value PUFAs (e.g., CLA) without thermal degradation

(A) P-4, Q-3, R-1, S-2

(B) P-2, Q-4, R-1, S-3

(C) P-3, Q-1, R-4, S-2

(D) P-1, Q-2, R-3, S-4

2006

151. Which factor is least relevant to the efficiency of continuous cholesterol removal from liquid milk fat using SCFE?

(A) The flow rate of supercritical CO_2

(B) The pressure and temperature in the extraction column

(C) The contact area between the milk fat and SC-CO_2

(D) The ambient atmospheric pressure in the processing plant

2004

152. It can be inferred that utilizing SC-CO_2 to fractionate butter into a high-melting point fraction and a low-melting point fraction allows a food manufacturer to:

(A) Create spreadable butter straight from the fridge

(B) Eliminate the physical need for any protective packaging materials

(C) Fully convert all unsaturated fatty acids into saturated fatty acids

(D) Permanently prevent lipid oxidation

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(B) The dominant background color utilized on the final retail product packaging design
(C) The specific geographical region and climate zone where the final food is distributed
(D) The exact weight percentage of organic ingredients, excluding water and salt

2001

184. In comparing organic dairy farming to conventional dairy processing, a key restriction applied to organic processing aids is that they must be:
(A) Formally listed on the national allowed substances list for organic processing
(B) Exclusively imported from certified foreign organic manufacturing facilities located outside the country
(C) Fully synthesized inside high-tech modern pharmaceutical laboratories under sterile conditions
(D) Capable of completely sterilizing the liquid dairy food matrix at ambient room temperature

2016

185. Which aspect is least relevant when an organic certification body audits a dairy processing facility?
(A) Traceability documentation of incoming raw organic milk
(B) The brand of office computers used by the management
(C) Pest control methods used within the processing plant
(D) The specific cleaning chemicals used on product contact surfaces

2012

186. From the widespread use of genetically modified (GM) starter cultures in certain regions, it can be inferred that:
(A) Traditional lactic acid fermentation of raw dairy products is fundamentally unsafe for human consumption.
(B) Recombinant DNA technology allows precise enhancement of phage resistance or ripening in dairy cultures.
(C) Genetically modified cultures require absolutely no organic nutrients to grow and survive in liquid milk.
(D) Every commercial cheese variety produced today relies heavily on the use of live genetically modified cultures.

2009

187. Which component is strictly eliminated from the final food product when an enzyme produced by a GM microorganism (like FPC) is highly purified before use?
(A) Recombinant DNA and live host cells
(B) The desired active enzyme itself
(C) The natural solvent water molecules
(D) The target peptide bonds of proteins

2005

188. What is a significant regulatory and commercial disadvantage of utilizing live Genetically Modified (GM) starter cultures in dairy products (e.g., GM yogurt)?
(A) They consistently ferment bulk liquid milk ten times slower than conventional wild-type starter strains.
(B) They are biologically fragile and cannot survive the highly acidic environment they naturally create.
(C) They face regulatory hurdles, mandatory GM labeling, and low consumer acceptance.
(D) They randomly and irreversibly alter the physical state of dissolved lactose during fermentation.

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2004

189. How does FSSAI (Food Safety and Standards Authority of India) define a Genetically Modified Food?
(A) Any commercial food product that has been thoroughly cooked or pasteurized using modern microwave energy.
(B) Only highly specialized experimental foods that exhibit luminescent properties and glow in the dark.
(C) Food varieties that have been selectively bred by traditional farmers over several hundreds of years.
(D) Food containing or produced from genetically modified organisms, regardless of residual GMO content

2009

190. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): Purified recombinant chymosin (FPC) does not typically require "GM" labeling on the consumer cheese package in many jurisdictions.
Reason (R): FPC is utilized as a processing aid and the highly purified enzyme preparation contains no detectable GM DNA or live GM host

(C) Transglutaminase – Syneresis reduction in set yogurt
(D) Lysozyme – Prevention of late-blowing defect in cheese by inhibiting Clostridium tyrobutyricum

2016
162. All of the following benefits of treating cheese milk with transglutaminase EXCEPT:
(A) Increased cheese yield due to incorporation of whey proteins into the casein network
(B) Improved texture and firmness of the curd
(C) Accelerated degradation of lactose into lactic acid
(D) Enhanced moisture retention in the final cheese

2022
163. What is the most appropriate kinetic model used to describe the enzymatic hydrolysis of lactose by β-galactosidase under standard conditions?
(A) Michaelis-Menten kinetics with galactose product inhibition
(B) Classical first-order irreversible decay kinetics
(C) Spontaneous zero-order molecular dissociation and decay kinetics
(D) Cooperative sigmoidal allosteric enzyme activation

2023
164. If transglutaminase is applied to milk intended for yogurt production, what conceptual change occurs to the protein matrix?
(A) The major dairy proteins are rapidly cleaved into much smaller, highly bitter tasting peptides.
(B) The milk proteins undergo highly extensive chemical Maillard browning at standard room temperature.
(C) Casein micelles completely and irreversibly disaggregate into free individual protein monomers.
(D) Isopeptide bonds form to create a stronger, more cross-linked three-dimensional network.

2004
165. The primary cause of the increased perceived sweetness in lactose-hydrolyzed milk is:
(A) The intentional addition of concentrated artificial chemical sweeteners during commercial lactase preparation.
(B) Hydrolysis of low-sweetness lactose into sweeter glucose and galactose.
(C) The enzymatic synthesis of high-fructose corn syrup within milk via active transglycosylation pathways.
(D) The selective biochemical elimination of hydrophobic bitter milk peptides during enzymatic treatment.

2011
166. Exogenous lipases used for accelerated cheese ripening are classified chemically as:
(A) Carbohydrate-cleaving active amylases and carbohydrases
(B) Proteolytic enzymes that systematically hydrolyze peptide bonds
(C) Esterases that cleave triglyceride ester bonds
(D) Electron-transferring and oxygen-scavenging oxidoreductases

2022
167. In comparing calf rennet to recombinant chymosin (Fermentation-Produced Chymosin, FPC) for cheese making:
(A) Calf rennet consists of entirely pure chymosin, whereas FPC is characterized by a variable blend of chymosin and pepsin enzymes.
(B) Recombinant FPC systematically induces severe bitter off-flavor development, unlike standard commercial microbial coagulants.
(C) Traditional calf rennet is a completely plant-based, vegetarian-friendly alternative to modern microbial coagulating agents.
(D) FPC offers high specificity for κ-casein cleavage but is produced by genetically modified microbes.

2011
168. Which factor is least relevant to the efficacy of exogenous proteases added to accelerate cheese ripening?
(A) The specific color of the cheese wax coating
(B) The global moisture content and water activity of the curd
(C) The environmental ripening and storage temperature
(D) The chemical pH value of the solid cheese matrix

2022
169. It can be inferred from the use of attenuated starter cultures in cheese making that:
(A) Their primary biological role is the rapid production of lactic acid during the initial vat fermentation stage.
(B) They are designed to lyse and release peptidases into the curd without producing excess acid.

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(C) They represent highly virulent bacteriophages specifically introduced to destroy undesirable spoilage bacteria.
(D) They are utilized to permanently halt the biochemistry of the ripening process to maximize product shelf life.

2014
170. Consider the following statements regarding exogenous cheese enzymes:
I. Excessive addition of broad-spectrum proteases often leads to a bitter defect.
II. Pregastric esterases are exclusively used to create the distinct piquant flavor of traditional Italian cheeses.
III. Recombinant chymosin is derived strictly from the exact genetic sequence of calf chymosin inserted into a host microbe.
IV. Exogenous lipases primarily break down proteins into short-chain amino acids.
Which of the above statements are correct?
(A) I, II and IV
(B) I, II and III
(C) II, III and IV
(D) I and III

2016
171. What is a primary disadvantage of using free (unencapsulated) exogenous enzymes directly in cheese milk for accelerated ripening?
(A) Most enzymes are lost in the whey during draining, reducing efficiency and contaminating the whey bypass.
(B) They are chemically unstable and completely fail to catalyze biochemical reactions at typical milk pH values.
(C) They exhibit extreme physical volatility and instantly vaporize upon direct contact with liquid rennet.
(D) They induce severe enzymatic oxidation that causes the entire cheese body to immediately turn dark blue.

2019
172. Define the process of "microencapsulation" as it relates to exogenous ripening enzymes in cheese.
(A) Physically squeezing the entire bulk cheese mass into highly specialized microscopic molds during pressing.
(B) Utilizing high-power microscopes to manually inject microscopic enzyme amounts into individual cheese blocks.
(C) Entrapping enzymes in liposomes or polymers to ensure retention in the curd rather than loss in whey.
(D) Thermally destroying all residual active enzymes using localized, high-frequency micro-wave radiation.

2024
173. Recall the specific bond in milk protein that chymosin highly specifically targets to initiate coagulation.
(A) The covalent ester bond linking glycerol molecules to short-chain butyric acid residues
(B) The highly stable intermolecular disulfide bridge present within native β-lactoglobulin
(C) The molecular 1,4-glycosidic bond connecting monosaccharide units in complex lactose
(D) The Phenylalanine-105 and Methionine-106 peptide bond of κ-casein

2013
174. Identify a major microbial host organism used commercially for the production of Fermentation-Produced Chymosin (FPC).
(A) The slow-growing pathogenic bacterium Mycobacterium tuberculosis
(B) The anaerobic spore-former Clostridium botulinum
(C) Aspergillus niger var. awamori or Kluyveromyces lactis
(D) The lactic acid bacterium Lactobacillus delbrueckii

2024
175. Identify the correct statement about accelerated cheese ripening using lipases.
(A) It specifically aims to degrade complex casein protein structures to prevent the development of bitterness.
(B) It releases short-chain free fatty acids (e.g., butyric, caproic) to develop sharp, mature flavors.
(C) It is shown to be completely ineffective and biologically inactive when applied to high-fat cheese varieties.
(D) It rapidly and systematically converts all available liquid milk fat components into solid, hard waxes.

2011
176. Identify the incorrect statement regarding organic food processing standards under the NPOP (National Programme for Organic Production) guidelines.
(A) Ionizing radiation treatments are strictly prohibited under organic guidelines.
(B) Genetically modified organisms are entirely banned from organic systems.

NODIA

(C) All processing aids must be specifically approved for organic processing.
(D) Synthetic food colors are allowed if the base milk is organic.

2018
177. Which pair correctly matches the organic certification entity/concept in India with its role?
(A) NPOP – The primary regulatory framework for organic production in India
(B) FSSAI – The global authority determining organic standards inside the United States
(C) APEDA – The agency directly responsible for banning all agricultural organic exports
(D) PGS-India – A standard developed exclusively for monitoring chemical pesticide usage

2012
178. Which pair incorrectly matches the chemical/processing aid with its status in organic dairy processing?
(A) Recombinant chymosin (FPC) – Generally prohibited due to its GMO origin
(B) Synthetic chemical preservatives (e.g., sodium benzoate) – Strictly prohibited
(C) High-dose gamma irradiation – Allowed for sterilizing organic milk packaging
(D) Natural microbial rennet (non-GMO) – Allowed for organic cheese making

2011
179. All of the following processing techniques are generally permitted in the production of certified organic liquid milk EXCEPT:
(A) Treatment with synthetic fungicidal washes
(B) Standard high-temperature short-time thermal pasteurization
(C) Mechanical high-pressure milk homogenization
(D) Centrifugal mechanical separation of milk fat

2025
180. Consider the following statements about organic dairy processing constraints:
I. Equipment must be meticulously cleaned to prevent the commingling of organic and non-organic products.
II. Only certified organic agricultural ingredients can be used, with very few exceptions for non-agricultural substances (like salt).
III. Nanotechnology applications for food packaging are widely approved and encouraged under organic standards.
IV. Boiler water additives must not contact organic products unless specifically approved.
V. Any naturally derived flavor is automatically approved without checking the extraction solvent.
Which of the above statement combinations is incorrect?
(A) I and II
(B) III and V
(C) II, IV and V
(D) I, III and IV

2010
181. Under organic processing regulations, if a dairy plant processes both conventional and organic milk on the same equipment, what conceptual procedure must be strictly implemented?
(A) The organic milk volume must be processed at a significantly higher pasteurization temperature.
(B) A documented, complete cleaning cycle must occur before the organic run to prevent commingling.
(C) The conventional milk batch must be temporarily labeled as certified organic for that operational day.
(D) The processing plant must utilize double the standard concentration of chemical chlorine sanitizers.

2017
182. The primary cause of the strict restriction on certain extraction solvents (like hexane) in organic processing is:
(A) Hexane chemical residues make the final dairy product taste excessively and unnaturally sweet to consumers.
(B) Hexane immediately evaporates during extraction and remains completely untraceable using analytical tools.
(C) Hexane is a petroleum-derived solvent that conflicts with organic natural processing standards.
(D) Hexane solvent is excessively expensive to source and purchase on an industrial scale compared to water.

2025
183. Organic certification schemes typically classify agricultural products as "100% Organic", "Organic", or "Made with Organic Ingredients" based on:
(A) The physical footprint and total capacity of the certified dairy processing plant

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(C) It operates under extremely low physical pressures, significantly reducing equipment costs.
(D) It inherently causes extreme thermal degradation, breaking down complex lipids.

2023
138. How is the critical point of a substance defined in a typical phase diagram?
(A) The specific thermodynamic point where solid, liquid, and gas phases coexist in stable equilibrium
(B) The endpoint of the liquid-gas curve, where separate liquid and gas phases cease to exist
(C) The exact temperature value at which a pure liquid substance completely freezes under 1 atmosphere of pressure
(D) The physical pressure threshold at which a solid substance sublimates directly into gas

2013
139. Recall the approximate critical temperature and critical pressure of Carbon Dioxide (CO_2).
(A) 31.1°C and 7.38 MPa (73.8 bar)
(B) 100.0°C and 0.10 MPa (1.0 bar)
(C) -56.6°C and 5.11 MPa (51.1 bar)
(D) 0.0°C and 100.00 MPa (1000.0 bar)

2025
140. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): Supercritical fluids are highly effective solvents for extraction processes in the food industry.
Reason (R): Supercritical fluids possess liquid-like densities allowing for high solvation power, and gas-like viscosities allowing for rapid mass transfer and penetration.
In the light of the above statements, choose the correct answer from the options given below:
(A) Both (A) and (R) are true and (R) is the correct explanation of (A).
(B) Both (A) and (R) are true but (R) is not the correct explanation of (A).
(C) (A) is true but (R) is false.
(D) (A) is false but (R) is true.

2025
141. Identify the correct statement regarding supercritical fluid extraction (SCFE).
(A) The solvating power of any supercritical fluid decreases systematically as its global density is increased during extraction.
(B) Supercritical fluid extraction is strictly a batch operation and cannot be configured to run semicontinuously.
(C) Supercritical water is the most universally utilized fluid for selectively extracting hydrophobic dairy lipids.
(D) Near the critical point, small changes in temperature or pressure yield large changes in density and solvent power.

2003
142. Identify the incorrect statement regarding the thermodynamics of SCFE.
(A) Isothermal compression of a supercritical fluid increases its density.
(B) The selectivity of extraction can be tuned by varying pressure and temperature.
(C) Below the critical pressure, the fluid remains in a true supercritical state regardless of temperature.
(D) Addition of a co-solvent (entrainer) like ethanol can change the polarity of the supercritical fluid phase.

2010
143. Which pair correctly matches the SCFE property to its physical state analogue?
(A) Viscosity – Similar to a solid
(B) Density – Similar to a liquid
(C) Diffusivity – Similar to a highly viscous liquid
(D) Surface tension – Extremely high, like water

NODIA

2006
144. Which pair incorrectly matches the phase diagram concept with its definition?
(A) Triple point – Unique thermodynamic conditions where solid, liquid, and gas phases coexist in equilibrium
(B) Sublimation curve – Boundary between solid and gas phases
(C) Critical temperature – The temperature above which a gas cannot be liquefied by pressure alone
(D) Supercritical region – The area below critical pressure and above critical temperature

2015
145. All of the following are recognized properties that make supercritical CO_2 highly desirable for food extraction EXCEPT:
(A) It is highly polar and excellent at extracting hydrophilic proteins.
(B) It is non-flammable.
(C) It is relatively inexpensive and generally recognized as safe (GRAS).

cells in the final cheese.
In the light of the above statements, choose the correct answer from the options given below:
(A) Both (A) and (R) are true and (R) is the correct explanation of (A).
(B) Both (A) and (R) are true but (R) is not the correct explanation of (A).
(C) (A) is true but (R) is false.
(D) (A) is false but (R) is true.

2016
191. Identify the factual application of recombinant DNA technology in the dairy industry.
(A) The biochemical synthesis of completely artificial and synthetic water molecules for dilution
(B) Production of recombinant bovine somatotropin to increase milk yield in dairy cows
(C) The complete and permanent removal of all natural divalent calcium ions from raw bovine milk
(D) The genetic creation of experimental dairy cows that do not require any fresh water intake

2003
192. Identify the correct statement regarding GM labeling regulations under FSSAI.
(A) FSSAI has put in place policies that outright ban all consumer food products containing any detectable DNA.`
(B) FSSAI has absolutely no legal regulations or safety guidelines regarding genetically modified foods.
(C) FSSAI dictates that all genetically modified foods must be synthetically dyed blue for rapid visual identification.
(D) FSSAI mandates labeling for foods with GM DNA or protein content above a specific threshold.

2008
193. Identify the incorrect statement regarding the safety of GM foods.
(A) Transfer of antibiotic resistance marker genes to gut microflora is not considered a risk and is never evaluated.
(B) Potential allergenicity is a major regulatory parameter evaluated during the safety assessment of any newly introduced GM protein.
(C) Rigorous toxicity studies must be conducted to ensure the GM food is substantially equivalent to its conventional counterpart.
(D) Food safety regulators systematically assess both intended and unintended compositional changes in the evaluated GM food.

2005
194. Which pair correctly matches the GM food concept with its definition?
(A) Recombinant DNA – Strands of genetic material that naturally mutate under the continuous influence of cosmic radiation
(B) Transgenic organism – A complex living organism that has had its entire set of native genes completely and synthetically removed
(C) Substantial equivalence – Treating a GM food as safe if it is compositionally identical to an existing food
(D) Marker gene – A specific sequence of DNA that is solely and directly responsible for producing desirable flavor compounds

2001
195. Which pair incorrectly matches the space food technology with its processing mechanism?
(A) Intermediate moisture foods – Addition of large amounts of free water to enhance shelf life
(B) Freeze-drying – Sublimation of ice under low pressure
(C) Thermostabilization – High-heat sterilization inside pouches or cans
(D) Zero-gravity packaging – Specialized valves and tethers to prevent food particles from floating

2016
196. All of the following are critical criteria for space food packaging EXCEPT:
(A) It must generate minimal weight and volume.
(B) It must prevent the release of crumbs or free liquids into the spacecraft cabin.
(C) It must withstand extreme changes in pressure and maintain an absolute barrier to moisture and oxygen.
(D) It must rely exclusively on heavy glass jars for absolute barrier protection.

2006
197. What is the most appropriate reason why traditional crumbly cheeses or dry powders without a liquid reconstitution system are avoided on space missions?
(A) These specific highly perishable dairy products tend to spoil instantly under the environmental conditions of zero gravity.
(B) Loose particles can float in microgravity,

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reaction produces volatile compounds, such as aldehydes and ketones, which lead to rancidity, metallic off-flavors, and serious quality defects, reducing the overall consumer acceptance of the processed milk.

29. (D) The generation of hydroxyl radicals causing the formation of dityrosine bonds
Exposure to high doses of ionizing radiation generates reactive hydroxyl radicals through water radiolysis in milk. These radicals attack aromatic amino acids in milk proteins, inducing covalent cross-linking, such as dityrosine bond formation. This structural modification changes the conformation and solubility of the proteins, leading to altered functional behaviors in dairy systems.

30. (B) I, II, III and V
Ionizing radiation significantly degrades highly sensitive vitamins like Vitamin C and fat-soluble Vitamin E, while also causing radiolytic cleavage of milk lipids into volatile hydrocarbons. These reactions produce prominent off-flavors, which can be mitigated by performing the irradiation process on milk in a frozen state to limit the mobility of free radicals.

31. (B) Irradiation causes more severe loss of antioxidant vitamins due to free radical scavenging than thermal pasteurization.
Irradiation generally causes a more severe depletion of antioxidant vitamins than thermal pasteurization because it generates highly reactive free radicals that scavenge these essential nutrients. This radical-mediated degradation pathway in milk targets both water-soluble and fat-soluble vitamins, requiring careful dose optimization to balance microbial safety and nutritional quality preservation.

32. (D) Lactose
Lactose is a disaccharide that is highly stable during food irradiation and does not contribute significantly to the formation of off-flavors. Instead, irradiation odor is driven by the radiolytic degradation of sulfur-containing amino acids and unsaturated fatty acids, which yields highly volatile, unpleasant sulfurous and oxidized carbonyl compounds in whole milk.

NODIA

33. (A) Irradiating milk under vacuum or inert gas reduces off-flavors.
The extreme susceptibility of milk fat to radiolytic oxidation implies that performing the process under vacuum or inert gas atmospheres significantly reduces off-flavors. Removing molecular oxygen limits the formation of hydroperoxides and volatile carbonyl compounds, helping preserve the fresh sensory profile of dairy products during low-dose pasteurization treatments.

34. (C) Irradiating the milk in a frozen state at cryogenic temperatures
Irradiating milk in a frozen state at cryogenic temperatures is highly effective for minimizing the degradation of milk constituents. The rigid ice lattice restricts the diffusion of radiolytic free radicals generated from water molecules, significantly reducing collateral chemical damage to proteins, lipids, and vitamins while still successfully inactivating target micro-organisms.

35. (A) It prevents radiolytic degradation of the food product.
Utilizing ionizing radiation to sterilize empty dairy packaging prior to aseptic filling avoids direct radiolytic degradation of the food product itself. This strategy protects delicate milk components from free radical damage, preventing lipid oxidation, protein cross-linking, and off-flavor development while achieving high hygiene standards for packaging materials.

36. (D) The cleavage of the polypeptide backbone by free radicals
Protein fragmentation is defined as the cleavage of the polypeptide backbone, a chemical change triggered when proteins are exposed to ionizing radiation. Free radicals generated from water radiolysis break covalent peptide bonds, reducing the molecular weight of proteins and altering their native tertiary structure and functional properties in food systems.

37. (B) Dipole rotation of water molecules and ionic polarization of dissolved salts
Microwave processing of liquid milk generates heat primarily through the dual mechanisms of polar dipole rotation of water molecules and ionic polarization of dissolved mineral salts. Under high-frequency alternating electric fields, water molecules rotate and ions migrate rapidly,

throwing off its center of gravity.

2015
204. Which field of study is effectively supplemented, though not entirely eliminated, by the advent of molecular nutrition?
(A) Traditional dietetics
(B) Public health nutrition
(C) Nutrigenomics
(D) Epidemiology

2018
205. What is a primary analytical advantage of applying metabolomics in dairy science?
(A) It utilizes destructive physical chemistry methods that permanently and completely destroy the entire organic sample matrix.
(B) It is analytically limited in scope and only identifies high-molecular-weight macromolecular proteins in dairy.
(C) It operates as a rapid thermal sensor that strictly measures the physical temperature changes of liquid milk.
(D) It profiles low-molecular-weight compounds to characterize cheese ripening and detect adulteration.

2013
206. Define "Nutrigenomics" in the context of food science.
(A) The highly specialized study of how to artificially and genetically modify agricultural and nutritional plants.
(B) The bioengineering of exceptionally giant genetic genomes using specialized nutritional supplements.
(C) Studying how dietary components and the genome interact to affect gene expression and regulation.
(D) The simple quantitative measurement and calculation of total calories present within a specific meal.

2018
207. Recall the specific "omic" technology that focuses on the large-scale study of all RNA transcripts produced by the genome under specific environmental or processing conditions.
(A) Complete structural genomics
(B) Active cellular transcriptomics
(C) Large-scale comparative proteomics
(D) Targeted dairy lipidomics

2018
208. Identify the factual statement regarding proteomics in dairy science.
(A) It is analytically limited and solely used to determine the exact fat content of liquid milk.
(B) It systematically maps out the entirely unchangeable and genetically fixed DNA sequence of any dairy bacterium.
(C) It is a highly specialized clinical tool that only applies to studying human metabolic physiology.
(D) It monitors stress-response protein up-regulation in starter cultures under acid or heat shock.

2001
209. Identify the correct statement about the application of metabolomics for traceability.
(A) Mapping specific metabolite profiles (biomarkers) to differentiate organic from conventional milk.
(B) Metabolomics is shown to be completely useless and highly unreliable for tracing the geographical origin of liquid milk.
(C) It works as a basic physical testing method that measures only the free water content of the analytical sample.
(D) It relies entirely on subjective visual inspection and digital imaging of the final food product's external color.

2009
210. Arrange the standard analytical workflow for a mass-spectrometry-based metabolomics study of cheese ripening:
I. Data processing and multivariate statistical analysis (e.g., PCA)
II. Sample extraction and metabolite derivatization
III. Identification of significant biomarkers
IV. Chromatographic separation (GC/LC) and mass spectrometry detection
Which of the following is the correct sequence?
(A) II, IV, I, III
(B) IV, II, I, III
(C) II, I, IV, III
(D) I, II, III, IV

NODIA

2002
211. Which pair correctly matches the "omic" field with its analytical target in dairy?
(A) Proteomics – The complement of proteins expressed by a starter culture at a given time
(B) Transcriptomics – The static, structural sequence of individual nucleotide base pairs in the native DNA

resistance. By utilizing scale and shape parameters, this flexible empirical model accurately describes both downward-concave shoulder phases and upward-convex tailing phases commonly observed during non-thermal processing of diverse food matrices.

10. (B) I and II
Electromagnetic radiation principles dictate that shorter wavelengths contain higher photon energy. Additionally, the penetration depth of electromagnetic energy is inversely proportional to its frequency because higher frequencies experience faster attenuation in conductive and polar media, which increases energy dissipation near the product surface while reducing the depth of direct wave penetration.

11. (A) Decrease the frequency to radio-frequency levels
Lowering the applied electromagnetic frequency to radio-frequency levels increases the wave penetration depth because lower frequencies undergo less attenuation in polar food matrices. This adjustment maintains strong dielectric interactions with ionic species and water molecules, permitting deeper volumetric heating inside large or thick food materials compared to high-frequency microwaves.

12. (C) Rapid dipole rotation causing internal friction and heat release
When microwave photons interact with liquid water molecules in dairy products, the alternating electric field causes these polar molecules to continuously realign. This rapid dipole rotation generates significant internal friction, converting electromagnetic energy directly into thermal energy, which results in rapid volumetric heating of the high-moisture phases of the food.

13. (D) By their ionizing potential and position on the spectrum
Electromagnetic waves applied in food processing are primarily categorized by their ionizing potential and their position on the electromagnetic spectrum. This classification separates non-ionizing radiation, such as microwaves, radio frequencies, and infrared, which generate heat through molecular interactions, from ionizing radiation, such as gamma rays and electron beams, which cause chemical dissociation.

14. (C) RF heating provides deeper, more uniform penetration in large food blocks than microwaves.
Radio-frequency heating systems operate at lower frequencies and longer wavelengths than microwaves, allowing the electromagnetic waves to penetrate much deeper and more uniformly into large, thick blocks of food. This deeper penetration reduces the risk of surface overheating and thermal runaway, making radio-frequency treatment highly effective for bulk processing.

15. (B) Magnetic polarization angle
The magnetic polarization angle of an electromagnetic wave has negligible influence on its heating mechanism within high-moisture food matrices. Instead, thermal generation in these materials is driven by electrical interactions, where the frequency, operating wavelength, and photon energy govern dielectric properties, ionic conduction, and the rotation of polar water molecules.

16. (D) Ejecting orbital electrons from atoms to create reactive ions
High-energy gamma rays possess sufficient photon energy to interact with food materials through ionization, ejecting orbital electrons from target atoms. This process produces highly reactive ions and free radicals without generating significant heat, allowing the treatment to disrupt microbial DNA and cellular structures at ambient temperatures for sterilization purposes.

17. (A) Direct thermal heating of the product surface
Transitioning from an infrared heating system to an ultraviolet system eliminates direct thermal heating of the product surface. While infrared waves transfer heat via radiative molecular vibration, ultraviolet radiation operates primarily through photochemical pathways, altering microbial DNA without transferring substantial thermal energy or causing temperature increases on the food surface.

18. (C) It requires longer processing times due to lower rates of energy transfer.
Utilizing low-frequency electromagnetic radiation in food processing requires longer treatment times due to lower rates of energy transfer compared to high-frequency systems. While low-frequency waves offer superior penetration depth, they deliver less overall energy per unit of

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2025

219. Which piece of information is least relevant when performing a proteomic analysis on a cheese sample to monitor proteolysis during ripening?
(A) The color of the laboratory walls
(B) The specific enzymes (e.g., chymosin, plasmin) active in the cheese
(C) The extraction protocol used to isolate the peptides
(D) The time and temperature of the ripening period

2019

220. Match the analytical technique/concept (List I) with its application in dairy omics (List II):
List I: (Analytical Technique/Concept)
P. NMR Spectroscopy
Q. 2D Gel Electrophoresis
R. Principal Component Analysis (PCA)
S. RNA sequencing (RNA-Seq)
List II: (Application in Dairy Omics)
1. Separating complex protein mixtures based on isoelectric point and molecular weight
2. Analyzing the complete transcriptomic profile of a lactic acid bacterium
3. Non-destructive, highly reproducible structural analysis of metabolites
4. Statistical tool used to find clustering and patterns in massive omic datasets
(A) P-1, Q-2, R-3, S-4
(B) P-4, Q-3, R-1, S-2
(C) P-3, Q-1, R-4, S-2
(D) P-2, Q-4, R-1, S-3

2009

221. Which field of study is effectively supplemented, though not entirely eliminated, by the advent of volatile metabolomics (flavoromics)?
(A) Standard microbiological plate counting
(B) Physical rheological compression testing
(C) Classical Kjeldahl total nitrogen analysis
(D) Human sensory evaluation panels

2014

222. What is an inherent advantage of using transcriptomics over simple plate counting to evaluate the health of a starter culture during processing?
(A) Transcriptomics methods are inherently much cheaper, faster, and simpler to execute than standard agar plating.
(B) The application of transcriptomics completely and irreversibly sterilizes the evaluated dairy milk samples.
(C) It details specific stress mechanisms and metabolic states of cells rather than just counting survivors.
(D) Performing transcriptomics requires absolutely zero specialized analytical instrumentation or computing power.

NODIA

2025

223. Define a "biomarker" in the context of food metabolomics.
(A) A physically visible barcode or adhesive label stuck on the exterior of a commercial food retail package.
(B) A measurable molecule whose concentration indicates a specific physiological state, origin, or history.
(C) A highly toxic, localized radioactive dye compound utilized to artificially color low-fat liquid milk.
(D) A specialized digestive enzyme that specifically and rapidly hydrolyzes complex complex carbohydrates.

2015

224. Recall the biological molecule that directly links the information in the genome (DNA) to the functional molecules in the proteome (proteins).
(A) Hydrophobic structural lipids
(B) Polymeric storage glycogen
(C) Structurally rigid cholesterol
(D) Messenger RNA (mRNA)

2005

225. Identify the factual application of proteomics in addressing dairy allergies.
(A) Identifying IgE-binding epitopes on allergens like β-lactoglobulin to design hypoallergenic processes.
(B) Completely and irreversibly removing all dissolved carbohydrate lactose molecules from liquid whole bovine milk.
(C) Artificially enhancing and accelerating the industrial production of unhealthy trans-fatty acids.
(D) Chemically changing the natural greenish-yellow background color of bulk acid or sweet cheese whey.

2014

226. Identify the correct statement regarding the stress response of lactic acid bacteria.
(A) They biologically respond to environmental osmotic stress by immediately and spontaneously exploding.
(B) They completely and irreversibly halt all active cellular RNA synthesis permanently

when chilled to 4°C temperatures.
(C) Heat shock triggers chaperone protein (e.g., GroEL) up-regulation to avoid misfolding, seen via proteomics.
(D) They synthetically produce and accumulate heavy lead inside their cells to actively block incoming radiation.

2015

227. Identify the incorrect statement regarding the application of systems biology (omics) to food processing.
(A) It has definitively proven that all processed foods are completely sterile.
(B) It enables the prediction of product shelf-life by modeling metabolic pathways.
(C) It provides a holistic view of the dynamic changes occurring during fermentation.
(D) It relies heavily on advanced bioinformatics and immense computational power.

2016

228. Which pair correctly identifies the omic strategy with its specific diagnostic strength in dairy?
(A) Transcriptomics – Quantifying the total exact mineral ash and inorganic trace element content of a food sample
(B) Genomics – Measuring the instantaneous physical rate of lactic acid production during industrial fermentation
(C) Proteomics – Determining the exact geographic altitude and environmental climate of the primary dairy farm
(D) Lipidomics – Identifying complex changes in triglyceride profiles during the lipolysis of mold-ripened cheeses

2006

229. Which pair incorrectly matches the stressor applied to a dairy culture with its typical cellular response studied via transcriptomics?
(A) Acid stress – Up-regulation of F_1F0-ATPase to extrude protons
(B) Osmotic stress (high salt) – Up-regulation of completely unrelated photosynthetic pathways
(C) Cold shock – Expression of cold-shock proteins (CSPs) to maintain membrane fluidity and RNA function
(D) Heat shock – Expression of molecular chaperones and proteases

2004

230. All of the following statements reflect how nutrigenomics could revolutionize personalized dairy nutrition EXCEPT:
(A) It allows for the formulation of targeted dairy products for individuals with specific genetic predispositions to metabolic syndrome.
(B) It can help elucidate why certain populations respond better to specific dairy bioactives than others based on single nucleotide polymorphisms (SNPs).
(C) It completely eliminates the need for humans to consume any macro-nutrients.
(D) It provides a scientific basis for the exact molecular health claims of functional dairy foods.

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ANSWERS

1. (A) The processing time required to reduce the surviving microbial population by 90 percent
The decimal reduction time represents the duration at a specific temperature needed to reduce the viable microbial population by ninety percent or one log cycle. This key kinetic parameter characterizes the heat resistance of target microorganisms under defined environmental conditions, assisting food engineers in establishing safe processing intervals for thermal sterilization operations.

2. (C) Z-value
The z-value is defined as the temperature change required to produce a tenfold change in the decimal reduction time. It represents the temperature sensitivity of a specific microorganism during thermal processing, allowing processors to calculate equivalent thermal death times across varying operational temperatures to optimize food safety while preserving nutrient quality.

3. (A) The presence of a sub-population of cells with higher resistance to treatment
In non-thermal microbial survivor curves, tailing describes a deviation from first-order kinetics where the death rate slows down. This phenomenon represents the existence of a highly resistant sub-population of cells within the culture. These robust cells survive initial treatment, highlighting heterogeneous resistance profiles that complicate the prediction of complete commercial pasteurization efficacy.

4. (D) The inactivation rate is directly proportional to the concentration of survivors present.
First-order microbial inactivation kinetics operate under the principle that the rate of cell death is directly proportional to the concentration of viable organisms present at any given time. Consequently, plotting survivor logs against processing time yields a straight line, showing that a constant fraction of the surviving microbial population is destroyed per unit of time.

5. (B) The D-value remains constant regardless of the processing medium's pH or water activity.
The decimal reduction time of a microorganism is not a static constant. It varies significantly based on environmental conditions of the food matrix, such as pH, water activity, fat content, and ionic strength. These compositional factors modify the structural stability of microbial biomolecules, alter cellular heat sensitivity, and shift the overall rate of thermal destruction.

6. (C) D-value – The negative reciprocal of the semi-log survivor curve's slope
The decimal reduction time is mathematically derived from the negative reciprocal of the slope of the semi-logarithmic survivor curve. This linear plot represents the logarithm of surviving microorganisms against processing time, meaning a steeper slope corresponds to a lower time requirement for a ninety percent reduction, characterizing faster microbial destruction.

NODIA

7. (D) Pulsed Electric Field – Completely linear log reductions at any field strength
Pulsed electric field processing typically produces non-linear survival curves rather than purely linear log reductions. The complex electrical interactions with cell membranes lead to diverse inactivation kinetic behaviors, including shoulder effects at low field strengths and tailing at high energy inputs, due to heterogeneities in cell size and physiological states.

8. (A) The exact specific heat capacity of the holding tube material
The physical heat capacity of holding tube materials has no direct thermodynamic influence on the inherent decimal reduction time of a microorganism during processing. The inactivation rate is determined solely by cellular attributes, such as physiological age and genetic resistance, and the surrounding matrix properties, including pH and water activity, which affect microbial survival.

9. (B) Weibull model
The Weibull model is highly suited for fitting non-linear microbial survivor curves because it accounts for biological variation in stress

posing an inhalation hazard and risking sensitive equipment damage.

(C) They fundamentally lack sufficient high-quality proteins and essential amino acids required by active astronauts.

(D) The complete lack of gravitational force causes these dry cheese solids to spontaneously combust inside the cabin.

2010

198. An intermediate moisture food (IMF) destined for space travel relies on which underlying concept for its preservation?

(A) Achieving the complete and absolute removal of all internal moisture molecules to reach an aw level of exactly 0.0

(B) Storing the packaged food products indefinitely at extreme temperatures approaching absolute zero inside the spacecraft

(C) Lowering water activity (aw) to 0.6–0.85 using humectants to inhibit microbes without full dehydration.

(D) Heavily saturating the entire volume of food ingredients with active, live protective probiotic bacterial strains

2010

199. The primary cause of the extended shelf-life of lyophilized (freeze-dried) space foods is:

(A) The extensive and irreversible thermal denaturation of all endogenous metabolic enzymes within the raw food tissue.

(B) The heavy, continuous incorporation of specialized synthetic chemical preservatives and antioxidant formulations.

(C) The continuous exposure of the packaging materials to highly intense solar ultraviolet radiation in deep space.

(D) Moisture removal via sublimation, lowering water activity below the threshold for microbial and chemical decay.

2008

200. Match the space food processing technique (List I) with its description (List II):

List I: (Space Food Processing Technique)

P. Lyophilization
Q. Thermostabilization
R. Irradiated foods
S. Intermediate moisture processing

List II: (Description)

1. Heating sealed pouches to achieve commercial sterility
2. Freezing followed by vacuum sublimation of ice
3. Using humectants to lower water activity while keeping food soft
4. Exposure to ionizing radiation to achieve sterility (e.g., space beef steaks)

(A) P-1, Q-2, R-3, S-4
(B) P-3, Q-1, R-4, S-2
(C) P-2, Q-1, R-4, S-3
(D) P-4, Q-3, R-1, S-2

2012

201. In comparing thermostabilized space foods to freeze-dried space foods:

(A) Thermostabilized foods are engineered to be significantly lighter in weight and volume than typical freeze-dried foods.

(B) Thermostabilized foods retain moisture and are ready-to-eat, while freeze-dried foods require rehydration.

(C) Freeze-dried dairy foods suffer from highly severe and irreversible textural collapse during processing, unlike thermostabilized variants.

(D) Thermostabilized food systems rely exclusively on low temperatures, while freeze-dried products require extremely high temperatures.

2006

202. Which specific packaging feature is most heavily relied upon for consuming liquids (like milk or juice) in a zero-gravity environment?

(A) An open, standard cylindrical drinking cup design

(B) A sealed pouch featuring a one-way valve and straw

(C) A perforated, non-insulated cardboard box structure

(D) A highly pressurized, mechanical aerosol spray nozzle

2024

203. It can be inferred that reducing the mass and volume of space food is critically important because:

(A) Launching payload into orbit is astronomically expensive per kilogram.

(B) Human astronauts naturally experience extremely small and depressed appetites while in outer space.

(C) The physical mass of food products directly interferes with the spacecraft's high-frequency communication arrays.

(D) Heavy food systematically sinks to the structural bottom of the spacecraft cabin,

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time, reducing the rapid heating rates typical of higher-frequency microwave systems.

19. (A) The use of high-dose ionizing radiation to achieve commercial sterility
Radappertization is a food preservation process that applies high doses of ionizing radiation to achieve commercial sterility. This treatment inactivates all vegetative cells, viruses, and highly resistant bacterial endospores, mimicking thermal canning processes to produce shelf-stable food products that can be safely stored at room temperature without risk of microbial spoilage.

20. (D) I, II and III
Radicidation, radurization, and Fricke dosimetry are key concepts in food irradiation technology. Radicidation targets specific non-spore-forming pathogens, radurization extends shelf-life by reducing spoilage microbes, and Fricke dosimetry utilizes chemical oxidation of ferrous to ferric ions to accurately measure absorbed doses. However, radappertization doses far exceed one kilogray to achieve sterility.

21. (B) Gray (Gy)
The Gray is the internationally recognized standard unit used to express the absorbed dose of ionizing radiation in food materials. It represents the absorption of one joule of radiation energy per kilogram of matter, allowing researchers and processors to standardize, monitor, and regulate treatment levels to ensure both microbiological safety and nutritional retention.

22. (C) Electron beams provide shallower penetration compared to gamma rays from Cobalt-60.
Electron beams generated from machine sources provide shallower penetration into food materials than high-energy gamma rays from Cobalt-60. While gamma rays can deeply penetrate large pallets of food, electron beams are highly suited for surface treatments or thin packages due to the limited physical penetration depth of accelerated electrons.

23. (D) It is synonymous with the complete elimination of all microbial spores.
Radurization is a low-to-medium dose irradiation process designed to extend the shelf-life of fresh food products by reducing viable populations of vegetative spoilage microorganisms, similar to pasteurization. It is not synonymous with complete microbial spore elimination, which requires much higher radiation doses associated with sterilizing treatments like radappertization.

NODIA

24. (A) Radappertization – 10 to 50 kGy
Radappertization requires high-dose ionizing radiation, typically ranging from ten to fifty kilograys, to guarantee the complete elimination of highly resistant bacterial endospores and achieve commercial sterility. Other applications, such as sprout inhibition or radicidation, utilize much lower radiation doses to prevent sprouting or control non-spore-forming pathogenic bacteria.

25. (B) Radiochromic film dosimeter – Physical measurement of induced radioactive decay
Radiochromic film dosimeters measure radiation doses through color changes induced by radiation-induced polymerization, rather than measuring active radioactive decay. This visual change is quantified spectrophotometrically, providing a simple, reliable method for routine dose mapping in commercial processing facilities, unlike chemical oxidation or electron spin resonance techniques.

26. (B) Neutron beams from nuclear fission reactors
Neutron beams from nuclear fission reactors are not approved for food irradiation because their high-energy interactions can induce radioactivity in food components. Approved ionizing radiation sources are strictly limited to Cobalt-60 gamma rays, machine-generated X-rays under five mega-electron volts, and electron beams under ten mega-electron volts to ensure consumer safety.

27. (A) Routine placement of chemical dosimeters on the food packaging
Placing chemical dosimeters directly on food packaging is the standard and most appropriate routine method to verify absorbed radiation doses in commercial facilities. These dosimeters undergo measurable chemical or physical changes that correlate with the radiation dose received, ensuring the process meets safety standards and regulatory pasteurization or sterilization requirements.

28. (C) Accelerated lipid oxidation producing aldehydes and off-flavors
Irradiating whole milk in an oxygen-rich environment triggers rapid lipid oxidation because ionizing radiation generates free radicals that react with unsaturated fatty acids. This

(C) Genomics – The specific profile of free fatty acids, polar lipids, and volatile organic compounds
(D) Metabolomics – The absolute quantitative measurement of all messenger RNA (mRNA) transcripts in the cell

2007

212. Which pair incorrectly matches the bioactive dairy component with its potential nutrigenomic effect?
(A) Conjugated Linoleic Acid (CLA) – Direct modulation of gene networks related to lipid metabolism
(B) Calcium and Vitamin D – Regulation of specific gene expression pathways involved in bone mineralization
(C) Butyrate – Epigenetic regulation of cell cycles via histone deacetylase (HDAC) inhibition
(D) Bioactive peptides – Up-regulation of ACE to purposefully cause hypertension

2019

213. All of the following analytical tools are heavily utilized in modern metabolomics profiling of food EXCEPT:
(A) Nuclear Magnetic Resonance (NMR) spectroscopy
(B) Simple glass thermometers
(C) Gas Chromatography-Mass Spectrometry (GC-MS)
(D) Liquid Chromatography-Mass Spectrometry (LC-MS)

2004

214. What is the most appropriate use of transcriptomics when studying a probiotic strain like Lactobacillus acidophilus during spray drying?
(A) To physically measure the final moisture content and water activity of the resulting dry milk powder.
(B) To engineering-wise determine the physical size and air flow rate of the industrial spray dryer needed.
(C) Identifying which specific genes are expressed or repressed under thermal and osmotic drying stress.
(D) To directly, synthetically, and permanently alter the genomic DNA sequence of the active probiotics.

2016

215. If a dairy scientist discovers a novel bioactive peptide in whey that significantly alters human inflammatory gene expression pathways, this discovery directly falls under the umbrella of:
(A) Classical thermodynamics
(B) Fluid mechanics
(C) Macroeconomics
(D) Nutrigenomics

2017

216. The primary cause of the massive data complexity generated in proteomic and metabolomic studies is:
(A) Simultaneous profiling of thousands of molecules that fluctuate based on processing.
(B) The analytical instruments used in these high-throughput studies are frequently broken and uncalibrated.
(C) The laboratory researchers routinely and manually enter raw data incorrectly into the databases.
(D) The outdated physiological theory stating that dairy food only contains three distinct molecule types.

2013

217. In the context of "omics" sciences, identifying an exact point mutation in the DNA of a bacteriophage that infects cheese starter cultures is classified as:
(A) Metabolomics
(B) Genomics
(C) Proteomics
(D) Transcriptomics

2011

218. In comparing targeted vs. untargeted metabolomics in detecting milk adulteration:
(A) Targeted metabolomics systematically ignores all previously known compounds and searches exclusively for novel chemical unknowns.
(B) Untargeted metabolomics scans entire profiles for anomalies, while targeted metabolomics quantifies predefined targets.
(C) Untargeted metabolomics operates as a strictly qualitative screening tool and cannot be interfaced with mass spectrometry systems.
(D) Targeted metabolomics requires absolutely no chemical reference standards or multi-point calibration curves to achieve quantitation.

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creating friction and converting electromagnetic energy into thermal energy volumetrically.

38. (C) Store electrical energy in an alternating electromagnetic field
The dielectric constant measures a food material's capacity to store electrical energy within an alternating electromagnetic field. This fundamental physical property determines how effectively electromagnetic waves penetrate and couple with the components of the food matrix, such as water and dissolved salts, during microwave or radio-frequency heating operations.

39. (D) It measures the efficiency of converting electromagnetic energy into heat.
The dielectric loss factor indicates the efficiency with which a food material converts stored electromagnetic energy into useful thermal energy. A higher loss factor results in faster heating rates within the microwave field, as polar molecules and ions dissipate the electrical energy as heat through internal friction and molecular movement.

40. (A) Both A and R are true and R is the correct explanation of A.
Microwave heating of frozen dairy products is highly uneven and susceptible to thermal runaway. This occurs because liquid water has a much higher dielectric loss factor than solid ice, causing any thawed regions to absorb microwave energy and heat up rapidly, which further accelerates local melting while frozen areas remain cold.

41. (B) Dielectric constant (epsilon′) – Ability to store electromagnetic energy
The dielectric constant represents the capacity of a food material to store electromagnetic energy when placed in an alternating electric field. This property, along with the dielectric loss factor, governs how electromagnetic radiation behaves during processing, dictating both wave propagation speed and thermal dissipation rates within the food matrix.

42. (D) Ice formation – Drastically increases the dielectric loss factor compared to liquid water
Freezing water into ice causes a sharp decrease in the dielectric loss factor because the rigid crystalline structure restricts the rotation of water molecules. This reduces the material's ability to dissipate microwave energy, meaning ice heats much slower than liquid water, which directly contributes to uneven temperature distribution in frozen foods.

43. (A) Visual color of the food
The visual color of a food product does not affect its dielectric properties, which are governed by compositional and physical factors. Moisture content, salt concentration, and processing temperature directly determine the dielectric constant and loss factor by influencing dipole rotation of water and ionic conduction in the alternating electromagnetic field.

44. (C) Applying alternating cycles of heating and equilibration (pulsing)
Applying alternating cycles of heating and equilibration, known as pulsing, is an effective strategy to mitigate the edge heating effect. This technique allows time for heat to transfer from hot outer edges to cooler interior zones via thermal conduction, resulting in a more uniform temperature distribution in packaged solid foods.

45. (D) It causes localized surface heating due to high ionic polarization, reducing penetration depth.
Adding sodium chloride to cheese sauce increases ionic polarization, which significantly boosts the dielectric loss factor at the product surface. This high surface absorption decreases microwave penetration depth, causing rapid heat generation to concentrate at the outer boundaries, which can result in surface burning while leaving the core cold.

46. (C) FIR has low penetration depth, absorbing and dissipating energy purely at the surface layer.
Surface burning during far-infrared processing occurs because these long wavelengths possess very low physical penetration depth in high-moisture foods. Consequently, the radiant energy is completely absorbed and dissipated within the outer boundary layer, causing rapid temperature increases and surface charring if the heat is not quickly conducted inward.

47. (B) NIR (short), MIR (medium), and FIR (long) wavelength emitters
Infrared emitters are classified based on their peak emission wavelengths into near-infrared, mid-infrared, and far-infrared categories. This classification relates directly to emitter

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reach their critical membrane potential faster, making them more susceptible to pulsed electric fields.

109. (D) Measured in kV/cm, acts as the driving force.
In pulsed electric field processing, the electric field strength, measured in kilovolts per centimeter, acts as the primary driving force for electroporation. This parameter represents the electrical potential difference applied across the treatment gap, directly dictating whether the critical transmembrane potential of target cells will be exceeded.

110. (A) Both A and R are true and R is the correct explanation of A.
Bacterial endospores exhibit high resistance to pulsed electric fields because they lack a highly fluid, functional lipid bilayer cell membrane, which is the primary target for electroporation. Their rigid, protective spore coat and dehydrated state protect them from electrical breakdown, rendering non-thermal PEF treatments ineffective against spores.

111. (B) The color of the food material
Calculating the specific energy input of a pulsed electric field treatment requires electrical and process parameters, including voltage, pulse duration, and pulse number, but is independent of food color. These values determine the total electrical energy delivered per unit mass of food, which governs microbial inactivation rates.

112. (C) 10 to 50 kV/cm
The typical range of electric field strengths applied for microbial inactivation in liquid foods using pulsed electric fields is ten to fifty kilovolts per centimeter. This high-voltage range provides sufficient energy to exceed the critical transmembrane potential of bacteria and yeasts, inducing irreversible electroporation and cell death.

113. (A) The system experiences higher current draw and potential arcing.
Increasing the electrical conductivity of a liquid milk matrix prior to pulsed electric field processing leads to higher current draw and a greater risk of electrical arcing. High conductivity reduces the electrical resistance of the medium, generating excessive heat and potential sparks between the electrodes during high-voltage pulses.

114. (C) Air bubbles present in the liquid passing between the electrodes
Localized arcing or sparking inside a pulsed electric field treatment chamber is commonly caused by air bubbles in the liquid passing between the electrodes. Air has a much lower dielectric breakdown strength than liquid food, causing the high-voltage field to discharge through the bubbles, which can damage the chamber.

115. (A) Yeasts and molds are more susceptible due to their larger size.
Based on cell morphology, yeasts and molds are more susceptible to pulsed electric field processing than bacteria due to their larger cellular size. A larger cell diameter experiences a higher induced transmembrane potential at a given electric field strength, allowing electroporation to occur at lower applied voltages.

NODIA

116. (D) Parallel-plate chambers offer a more uniform electric field distribution, whereas co-axial chambers provide better fluid flow dynamics.
Parallel-plate design features flat, parallel electrodes that generate highly homogeneous electric fields, ensuring uniform treatment of fluids passing through them. Conversely, co-axial configuration utilizes concentric cylinders, which naturally cause non-uniform field distribution due to varying distance from the center, but offer superior fluid handling characteristics, minimizing dead zones and reducing pressure drops during continuous processing operations.

117. (B) The ambient humidity of the storage warehouse
The structural design of high-voltage pulse generators relies on technical parameters like peak voltage, pulse shape, and capacitor capacitance to determine electrical components and circuitry. Ambient conditions of storage facilities do not influence the functional engineering layout of active pulse-generating components, as these systems are designed based on operational load and electrical load characteristics.

118. (C) PEF pulses generate unavoidable Joule (ohmic) heating within the treated liquid.
Pulsed electric field technology acts as a non-thermal preservation method, but applying high-voltage pulses to conductive fluids like milk inevitably generates heat due to electrical resistance. This phenomenon, known as Joule

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electrical conductivity of the pumpable food product.

58. (B) Joule heating rate – Proportional to the applied voltage gradient squared
The Joule heating rate in an ohmic system is directly proportional to the square of the applied voltage gradient. This relationship means that small increases in voltage lead to significantly higher rates of internal heat generation, allowing precise control over thermal processing profiles in conductive liquid food products.

59. (A) Heat exchanger plates – Generate the internal electrical resistance
In an ohmic heating system, heat exchanger plates are not used to generate electrical resistance; instead, heat is generated within the food material itself due to its natural electrical resistance. The key system components include electrodes to deliver current, an insulated tube to prevent leakage, and an AC power supply.

60. (B) III, I, II, IV
The correct sequence of operations in ohmic heating begins with pumping the liquid product into the column, followed by its passage through the electrical field between the electrodes. Internal heat is then generated via the Joule effect, and the pasteurized product is subsequently cooled and filled into packaging.

61. (D) To prevent electrochemical reactions and metal dissolution at electrodes
Utilizing alternating current rather than direct current is essential in ohmic heating to prevent electrochemical reactions and metal dissolution at the electrodes. Alternating the electrical polarity at frequencies such as fifty to sixty hertz minimizes electrolysis, reduces electrode fouling, and prevents toxic metal contamination of the processed food.

62. (C) By formulating the liquid phase to have a lower electrical conductivity than solids
To ensure solid particles heat faster than the liquid phase during ohmic heating, the liquid phase must be formulated with a lower electrical conductivity than the solids. This conductivity difference causes a higher electrical resistance in the solid particles, leading to accelerated localized heat generation within the solid phase.

63. (B) It increases electrical conductivity, causing faster heating at a given voltage gradient.
Increasing the salt concentration in whey boosts its electrical conductivity, which leads to faster internal heating at a given voltage gradient. The higher concentration of free ions reduces electrical resistance, allowing more current to flow and accelerating the Joule heating rate during the thermal processing of the liquid.

64. (D) Direct volumetric internal heating
Ohmic heating is classified as a direct volumetric internal heating method because heat is generated directly within the entire volume of the food product. This mechanism avoids the limitations of heat transfer through physical boundary walls, enabling rapid, uniform temperature increases in pumpable liquid and multiphase food systems.

65. (A) Ohmic heating prevents fouling on hot heat-exchange surfaces.
Unlike conventional tubular heat exchangers, ohmic heating systems generate heat internally within the fluid, which prevents fouling on hot heat-exchange surfaces. This lack of hot boundaries is highly advantageous for processing high-viscosity or heat-sensitive dairy products, as it minimizes protein denaturation and burning at the tube walls.

66. (C) Color of the liquid matrix
The color of the liquid matrix has no physical relevance to the intensity of acoustic cavitation during high-intensity ultrasound processing. Cavitation intensity is governed by mechanical and environmental properties of the liquid, such as hydrostatic pressure, surface tension, viscosity, and the frequency of the applied ultrasonic waves.

67. (A) The localized extreme temperatures and pressures generated during cavitation bubble collapse
Sonochemical radical generation is driven by the extreme localized temperatures and pressures produced during the violent collapse of acoustic cavitation bubbles. These intense hotspot conditions cause the homolytic cleavage of water molecules into reactive hydroxyl and hydrogen radicals, initiating oxidation reactions within the surrounding liquid medium.

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68. (D) Ionizing radiation-induced radiolytic cleavage
Ionizing radiation-induced radiolytic cleavage is completely absent during purely non-thermal, low-frequency ultrasonic processing. The physical mechanisms of ultrasound are mechanical in nature, utilizing acoustic cavitation, micro-streaming, and shear forces to disrupt structures, without the high photon energies required to eject orbital electrons or cause ionization.

69. (B) Sonochemical free radicals can accelerate lipid oxidation and off-flavors.
A primary disadvantage of high-intensity ultrasound in lipid-rich dairy processing is that sonochemical free radicals can accelerate lipid oxidation, generating off-flavors and reducing quality. The reactive species produced during cavitation bubble collapse attack unsaturated fatty acids, yielding volatile carbonyl compounds that impair the sensory profile of the dairy product.

70. (B) A is true but R is false.
High-intensity ultrasound processing often increases the temperature of the treated liquid. This thermal rise occurs because the mechanical energy of acoustic waves and the violent collapse of cavitation bubbles dissipate directly into the bulk fluid as heat, rather than cooling the medium through bubble expansion as pressure decreases.

71. (D) Acoustic cavitation
Acoustic cavitation is the physical process where microscopic gas bubbles form, grow, and violently collapse within a liquid subjected to ultrasonic waves. This phenomenon is responsible for generating localized high-shear forces, micro-streaming, and extreme hotspots, which drive both chemical reactions and physical disruption in processed foods.

72. (B) 20 to 100 kHz
High-intensity power ultrasound typically operates in the frequency range of twenty to one hundred kilohertz for food processing. This low-frequency range is highly effective at inducing transient acoustic cavitation, creating the severe mechanical shear forces and physical effects needed for homogenization, degassing, and cell disruption.

73. (B) Stable cavitation bubbles oscillate without violent collapse.
Stable cavitation bubbles oscillate continuously over many acoustic cycles without undergoing violent collapse. In contrast, transient cavitation bubbles expand rapidly and collapse violently within a few cycles, producing extreme localized shear, heat, and pressure that drive cell disruption and chemical reactions in the surrounding liquid medium.

74. (B) Sonochemical reactions only occur at bulk liquid temperatures above 100°C.
Sonochemical reactions do not require bulk liquid temperatures above one hundred degrees Celsius to occur. Instead, these reactions are driven by highly localized hotspots generated during cavitation bubble collapse, where temperatures reach several thousand Kelvin within microsecond timescales, even while the bulk fluid remains at ambient temperature.

75. (A) Low-intensity, high-frequency ultrasound – Non-destructive quality monitoring
Low-intensity, high-frequency ultrasound is widely applied in the dairy industry for non-destructive quality monitoring. Because these high-frequency waves propagate through food without causing physical or chemical damage, they can be used to measure composition, detect structural defects, and monitor processes like coagulation in real time.

76. (C) Crystallization control – Destruction of seed crystals to prevent lactose growth
Controlling lactose crystallization using ultrasound relies on promoting nucleation rather than destroying existing crystals. Acoustic cavitation induces secondary nucleation, which increases the crystallization rate and results in a higher number of smaller crystals, preventing the formation of large, sandy crystals in concentrated dairy products.

77. (D) Complete cleavage into single free amino acids
High-intensity ultrasound modifies the structures and functional properties of dairy proteins without cleaving them into single free amino acids. While cavitation disrupts casein micelles, alters surface hydrophobicity, and improves foaming capacity, it lacks the enzymatic or highly specific chemical capacity required to break all peptide bonds.

NODIA

78. (C) Acoustic cavitation induces secondary nucleation, accelerating crystallization.
The enhanced crystallization of lactose under ultrasound treatment is due to acoustic cavitation inducing secondary nucleation. The intense pressure waves and micro-streaming break existing crystals and generate new nucleation sites, accelerating the crystallization rate and producing a uniform population of small lactose crystals in concentrated whey.

79. (B) Application of mild heat and mild pressure simultaneously
Thermomanosonication combines high-intensity ultrasound with mild heat and moderate pressure to maximize microbial inactivation. This synergistic combination increases cavitation intensity and destabilizes cell membranes, significantly reducing the treatment time and temperature required to pasteurize raw milk compared to using thermal or acoustic energy alone.

80. (D) I and III
High-intensity ultrasound effectively homogenizes milk fat by breaking down globule sizes and can selectively inactivate enzymes by altering protein structures. However, it does not typically inhibit yogurt starter cultures when applied correctly; rather, mild treatments can stimulate bacterial growth and reduce overall fermentation times.

81. (A) Heat and high-intensity ultrasound
Thermosonication is a hybrid process that simultaneously applies moderate thermal energy and high-intensity ultrasound to achieve microbial and enzymatic inactivation. The combined effects of heat-induced membrane destabilization and acoustic cavitation-induced mechanical shear provide high lethality, reducing the thermal load required to pasteurize liquid foods.

82. (C) Ultrasound uses cavitation to disrupt globules, while mechanical valves rely on pressure drops.
Ultrasound-assisted homogenization uses acoustic cavitation to generate intense local shear forces that disrupt fat globules, whereas conventional mechanical homogenizers rely on high-pressure drops through narrow valves. Both methods reduce fat globule size, but ultrasound achieves this disruption through localized bubble collapse rather than macroscopic pressure differentials.

83. (A) Ambient room lighting
Ambient room lighting has no physical influence on the efficiency of microbial inactivation by high-intensity ultrasound. The inactivation rate is determined by biological factors, such as the target species and load, and fluid properties, including viscosity and dissolved gas content, which dictate cavitation intensity.

84. (D) It disrupts starter cultures to release internal ripening enzymes.
Applying ultrasound can accelerate cheese ripening by disrupting starter culture cells to release intracellular ripening enzymes. The mechanical shear from cavitation permeabilizes cell membranes, releasing proteases and peptidases directly into the curd matrix, which speeds up biochemical breakdown and reduces the time required for flavor development.

85. (B) The formation of large, coarse ice crystals
Utilizing ultrasound during the freezing of ice cream controls ice crystallization, eliminating the formation of large, coarse ice crystals. Acoustic cavitation induces secondary nucleation, promoting the rapid growth of numerous small ice crystals, which improves the smooth texture and overall quality of the frozen dessert.

86. (C) HHP is transmitted uniformly throughout the food matrix regardless of size.
A key advantage of high hydrostatic pressure processing is that pressure is transmitted uniformly and instantly throughout the food matrix, regardless of product size or shape. This isostatic transmission ensures consistent processing throughout the food, avoiding the temperature gradients and slow heat transfer typical of thermal treatments.

87. (D) Pressure is transmitted uniformly and instantly, regardless of food shape or size.
The isostatic pressure rule states that high pressure is transmitted uniformly and instantly throughout a compressed medium. Consequently, the food product experiences equal pressure from all directions simultaneously, ensuring that processing is independent of the size, shape, or geometry of the food within the treatment vessel.

88. (A) Any phenomenon accompanied by a decrease in volume is enhanced by an increase in pressure.
Le Chatelier's principle states that applying high hydrostatic pressure shifts chemical and physical

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non-uniform electric fields, typically produced around sharp points, needles, or fine wires where field enhancement is maximized. This contrasts with dielectric barrier discharge, which uses insulating barriers, and plasma jets, which direct active plumes onto surfaces, or high-frequency microwave systems that ionize gas.

128. (D) Intracellular boiling caused by massive direct heat transfer
Cold plasma is a non-thermal decontamination technology that inactivates microorganisms through several physical and chemical pathways. These include ultraviolet radiation causing DNA damage, cell surface etching by reactive species, and lipid peroxidation of membranes by active oxygen radicals. Because the process operates near ambient temperature, it does not cause thermal effects like intracellular boiling.

129. (A) Air or Nitrogen/Oxygen mixtures
Generating reactive nitrogen species during cold plasma processing requires gas mixtures containing both nitrogen and oxygen, such as ambient air. The ionization of these molecular gases under strong electric fields produces active nitrogen-based radicals, which exhibit potent antimicrobial properties, whereas pure noble gases like argon or helium generate different profiles of active species.

130. (B) II, IV, III, I
The physical formation of cold plasma in a dielectric barrier discharge system begins with applying a high-voltage alternating electric field across the gas gap. This field accelerates free electrons, which collide with neutral gas molecules. These high-energy collisions cause widespread ionization, generating more electrons and ions, which ultimately produce highly reactive secondary chemical species.

131. (A) Chemical action of active oxygen species reacting with cell macromolecules
Localized surface etching of microbial cells during cold plasma treatment is driven by chemical reactions of active oxygen and nitrogen species with cellular macromolecules. These highly reactive radicals oxidize proteins, lipids, and peptidoglycans on the cell wall, converting solid biological components into volatile compounds, which destabilizes the cell structure and leads to physical lysis.

132. (D) The fourth state of matter, containing an ionized gas
Physically, cold plasma is classified as the fourth state of matter, consisting of a partially ionized gas. It contains a dynamic mixture of free electrons, positive ions, ultraviolet photons, excited atoms, and highly reactive neutral radicals. It is termed non-thermal because the electrons possess high energy while the heavy ions and neutral particles remain near ambient temperature.

133. (B) In-package treatment uses internal gas to generate plasma, eliminating post-process contamination.
In-package cold plasma treatment applies high-voltage electric fields directly across sealed packages, utilizing the gas inside to generate reactive species. This approach sterilizes the food surface and headspace after packaging, completely preventing post-process contamination. Conversely, direct plasma jets apply active gas plumes onto exposed surfaces before packaging, risking exposure to ambient pathogens.

134. (C) The color of the external electrodes
The efficacy of cold plasma decontamination depends on operational parameters including applied voltage, electrical frequency, treatment time, and humidity of the feed gas. These factors directly dictate the concentration and type of reactive species generated. Conversely, physical characteristics like the color of the external electrodes have no impact on the ionization process or microbial inactivation.

135. (D) Decontaminating surfaces of solid foods and packaging
Due to the shallow penetration depth of reactive gas species and ultraviolet photons, cold plasma is highly suited for surface decontamination of solid foods and packaging materials. It cannot penetrate deeply into dense food matrices or large liquid volumes, making it ineffective for bulk sterilization, but ideal for extending the shelf life of fresh produce and cheeses.

136. (A) The distinction between liquid and gas phases
When a substance is compressed and heated beyond its unique critical temperature and pressure, it enters the supercritical state. At this thermodynamic point, the physical boundary

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Pressure disrupts non-covalent bonds, unfolding the proteins and exposing sulfhydryl groups; upon depressurization, these proteins network and gel at room temperature, forming unique rheological structures.

99. (A) The native fresh flavor profile of the raw milk
High hydrostatic pressure-treated milk maintains the native fresh flavor profile of raw milk much better than thermally pasteurized milk. Because pressure does not affect the covalent bonds of volatile flavor compounds, it avoids the cooked off-flavors and thermal degradation associated with conventional pasteurization processes.

100. (A) II and V
While high hydrostatic pressure is used to accelerate ripening and modify whey gels, it does not homogenize milk fat into nano-emulsions or deactivate heat-resistant endospores at four hundred megapascals. Spore inactivation requires far higher pressures paired with heat, and fat globules require mechanical shear for homogenization.

101. (B) Continuous processing of liquids requires specialized valves to handle extreme pressure drops.
Because high hydrostatic pressure is predominantly a batch process, continuous liquid processing requires specialized high-pressure valves and systems to manage rapid decompression. These design adaptations allow liquid foods to transition from extreme vessel pressures to atmospheric conditions safely and continuously without damaging the processing equipment.

102. (C) The loss of highly nutritious whey proteins into whey
Utilizing milk treated with high hydrostatic pressure in cheese manufacturing effectively eliminates the loss of highly nutritious whey proteins into the whey stream. The pressure-induced denaturation of these proteins causes them to bind with the casein network, retaining valuable nutrients in the final cheese curd.

103. (D) HHP alone at ambient temperatures cannot reliably destroy bacterial endospores.
A major disadvantage of using high hydrostatic pressure to process raw milk for long-term ambient storage is that pressure alone at room temperature cannot destroy bacterial endospores. Achieving shelf stability requires combining high pressure with thermal energy, as spores remain viable under standard non-thermal pressure levels.

104. (A) Applying pressure to lyse cells, releasing intracellular enzymes into the curd.
In high hydrostatic pressure processing, accelerated cheese ripening is achieved by applying pressure to lyse starter culture cells, releasing their intracellular enzymes into the curd. This rapid release of proteases and peptidases speeds up proteolytic breakdown, reducing the storage time required to develop characteristic flavors.

105. (A) II, IV, I, III
A typical high hydrostatic pressure processing cycle begins with loading the packaged product into the vessel and closing it. Next, the pressure-transmitting fluid is pumped inside during compression, followed by holding the target pressure for a set time, and concluding with depressurization and product unloading.

106. (B) Electroporation of the cell membrane
The primary mechanism of microbial inactivation in pulsed electric field processing is the electroporation of the cell membrane. Applying high-voltage pulses creates an electric field that induces a transmembrane potential, forming temporary or permanent pores in the lipid bilayer that disrupt cellular integrity and cause death.

107. (A) It is the membrane threshold voltage where pore formation occurs.
The critical transmembrane potential in pulsed electric field processing represents the electrical threshold voltage required to induce pore formation across the cell membrane. When the induced potential exceeds this critical limit, structural breakdown of the lipid bilayer occurs, leading to electroporation and subsequent inactivation of the microorganism.

108. (C) Larger cells require higher field strengths than smaller cells.
Larger cells do not require higher electric field strengths than smaller cells; rather, they require lower field strengths to achieve electroporation. The induced transmembrane potential is proportional to cell size, meaning larger cells

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equilibria toward states that occupy a smaller volume. Consequently, phenomena accompanied by a volume decrease, such as the dissociation of certain salts or protein conformational changes, are enhanced, while volume-increasing reactions are inhibited.

89. (B) Fluid and food temperatures increase slightly during compression.
During high hydrostatic pressure processing, adiabatic heating causes a slight increase in fluid and food temperatures during the compression phase. As pressure rises, the volume decreases, releasing heat; this temperature change is fully reversible, and the system cools back to its initial temperature upon depressurization.

90. (B) II, III and IV
High hydrostatic pressure principles dictate that non-covalent bonds are highly sensitive to pressure, while covalent bonds remain unaffected. Adiabatic compression of water causes a temperature rise of approximately three degrees Celsius per hundred megapascals, and pressure transmission relies on the low compressibility of liquid media like water.

91. (A) High hydrostatic pressure decreases the melting point of all solid lipids universally.
High hydrostatic pressure does not decrease the melting point of all solid lipids universally; rather, pressure typically increases the melting points of lipids, causing them to crystallize at higher temperatures. HHP promotes system volume reduction and protein unfolding, and adiabatic temperature rises are reversible upon depressurization.

92. (C) Le Chatelier's principle – Disruption of protein quaternary structure due to volume decrease
Le Chatelier's principle governs the disruption of protein quaternary structure under pressure because the dissociation of protein complexes is accompanied by a decrease in system volume. Non-covalent bonds stabilizing these complex structures are disrupted, leading to unfolding and potential gelation without affecting low-molecular-weight covalent flavor compounds.

93. (D) Covalent bonds – Highly sensitive, readily broken
Covalent bonds are highly resistant to high hydrostatic pressure up to eight hundred megapascals, remaining intact during treatment. This resistance allows small molecules, such as vitamins and flavor compounds, to be preserved, while larger biomacromolecules stabilized by pressure-sensitive non-covalent bonds, like proteins, undergo structural modifications.

94. (C) Substantial generation of radiolytic free radicals
High hydrostatic pressure processing does not generate significant amounts of radiolytic free radicals. Unlike ionizing radiation, which chemically cleaves water to form radicals, high-pressure processing uses purely mechanical compression that shifts phase transitions, denatures complex proteins, and induces gelation through the disruption of non-covalent bonds.

95. (B) Potable water or a water-glycol mix
Potable water or a water-glycol mixture is the most appropriate pressure-transmitting fluid for commercial high hydrostatic pressure systems. These fluids are non-toxic, inexpensive, and exhibit low compressibility, allowing efficient pressure transmission and generation within the vessel while ensuring safety in the event of any packaging leaks.

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96. (D) They will dissociate into sub-micelles as non-covalent bonds are disrupted.
Subjecting raw milk to high hydrostatic pressure causes casein micelles to dissociate into smaller sub-micelles. The high pressure disrupts the hydrophobic and electrostatic interactions that stabilize the micellar structure, leading to structural disintegration that alters the physical and optical properties of the milk matrix.

97. (A) HHP denatures whey proteins to co-precipitate with casein.
Applying high hydrostatic pressure to cheese milk increases cheese yield because the treatment denatures whey proteins, allowing them to co-precipitate with casein. This denaturation incorporates moisture-retaining beta-lactoglobulin into the curd network, reducing protein loss in the whey and increasing the total mass of cheese produced.

98. (C) "Cold set gelation" driven by non-covalent bond disruption
High hydrostatic pressure-induced gelation of whey proteins is characterized as cold set gelation because it occurs without elevated temperatures.

or ohmic heating, increases the product temperature during processing, necessitating integrated cooling systems to prevent thermal damage to heat-sensitive milk components and maintain quality.

119. (D) High-capacity steam boilers for direct heating
Unlike conventional ultra-high temperature thermal processing systems, which rely on massive steam boilers to inject heat and achieve commercial sterility, pulsed electric field processing inactivates microorganisms through non-thermal electroporation. Consequently, high-capacity steam boilers are unnecessary in a pure pulsed electric field line, significantly reducing carbon emissions, fuel consumption, and physical space requirements.

120. (A) P-1, Q-2, R-3, S-4
Different pulse wave shapes possess distinct characteristics for microbial inactivation. Exponential decay pulses are simple to generate but exhibit slow voltage drops. Square waves maintain peak voltage consistently, maximizing energy efficiency. Bipolar pulses reverse polarity, which significantly reduces electrochemical reactions and electrode fouling. Oscillatory waves fluctuate, rendering them the least efficient for uniform membrane permeabilization.

121. (B) An electrode assembly through which liquid flows continuously during electrical pulsing
Continuous flow pulsed electric field treatment chambers are specifically engineered for high-throughput processing. They consist of a structured chamber housing electrodes where liquid products flow continuously while receiving high-voltage pulses. This design ensures that all elements of the moving fluid experience a uniform electric field, allowing for successful non-thermal pasteurization of liquid foods on an industrial scale.

122. (B) Titanium or marine-grade stainless steel
Electrodes in pulsed electric field treatment chambers must withstand high voltage, continuous fluid shear, and corrosive liquid foods. Titanium and marine-grade stainless steel are preferred materials because they provide exceptional resistance to electrochemical erosion, prevent metal ion migration into the product, and comply with strict sanitary standards required for commercial food manufacturing equipment.

123. (A) It inactivates vegetative pathogens while preserving flavor and nutrition better than thermal pasteurization.
Applying pulsed electric fields to liquid milk successfully inactivates vegetative pathogenic and spoilage microorganisms through electroporation of cell membranes. Because this process occurs without intense thermal exposure, it preserves heat-sensitive vitamins, nutritional value, and natural flavor attributes far better than traditional thermal pasteurization methods, although the final treated product still requires continuous refrigerated storage.

124. (B) It refers to the number of electrical pulses delivered per second.
Pulse frequency is a key parameter in pulsed electric field systems that measures the total number of high-voltage pulses discharged into the treatment chamber per second, expressed in Hertz. This parameter determines the total energy delivered over time and must be optimized relative to flow rate to guarantee that every fluid element receives sufficient pulses.

125. (D) PEF requires the food to be placed in an alternating magnetic field.
Pulsed electric field processing utilizes high-voltage electrical pulses applied across electrodes to induce electroporation, not alternating magnetic fields. The system requires liquid foods with moderate conductivity, free from air bubbles, as dissolved gases can lower dielectric strength and trigger electrical arcing, which damages the treatment chamber and reduces the overall efficacy of pasteurization.

126. (C) Reactive oxygen species (ROS) – Includes ozone, singlet oxygen, and hydroxyl radicals
Cold plasma processing generates a variety of highly reactive chemical species through the ionization of gas. Reactive oxygen species, which include ozone, singlet oxygen, superoxide, and hydroxyl radicals, are primary agents of microbial inactivation. These active chemical agents react with cellular membranes, proteins, and genetic material, leading to cell death without heating the food matrix.

127. (B) Corona Discharge – Relies on highly uniform parallel flat plates with zero electric field enhancement
Corona discharge is a non-thermal plasma generation method that depends on highly

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temperature, which determines the spectral distribution of the radiation and dictates how effectively the emitted energy matches the absorption characteristics of water and other food components.

48. (D) FIR matches the absorption bands of water better, leading to efficient surface heating.
Far-infrared radiation matches the molecular absorption bands of liquid water extremely well, leading to highly efficient heat absorption at the food surface. This characteristic makes far-infrared heating highly effective for surface pasteurization and dehydration processes, although its limited penetration depth prevents deep volumetric heating in thick solid products.

49. (A) Electrical conductivity
Electrical conductivity is not a relevant factor in determining the efficiency of infrared heating because infrared transfer relies on electromagnetic radiation rather than current flow. Instead, properties like surface emissivity, moisture content, and surface color govern how effectively a dairy product absorbs and utilizes the incoming radiant thermal energy.

50. (A) P-4, Q-1, R-3, S-2
Infrared terminology matches specific thermal and physical characteristics during food processing. Near-infrared radiation penetrates slightly deeper than longer wavelengths, while far-infrared matches peak water absorption bands. High emitter temperatures produce short near-infrared wavelengths, and emissivity measures a material's capability to radiate the thermal energy it has absorbed.

51. (A) Convective heat losses to air
Utilizing infrared radiation within a vacuum chamber for surface dehydration of cheese completely eliminates convective heat losses to the surrounding air. Because vacuum conditions lack a gas medium to conduct or convect heat, energy transfer is restricted to pure radiative pathways, maximizing process efficiency and direct surface heating.

52. (D) It facilitates rapid start-up times and high energy transfer directly to the surface.
Infrared surface pasteurization of baked dairy products offers rapid start-up times and high energy transfer rates compared to conventional hot-air ovens. The radiative energy directly targets the surface layer, achieving rapid microbial decontamination and surface browning without requiring prolonged preheating times or complex convective air handling systems.

53. (B) By Wien's displacement law
Wien's displacement law mathematically defines the relationship between the peak emission wavelength of an infrared emitter and its absolute temperature. This fundamental thermodynamic law shows that as emitter temperature increases, the peak wavelength shifts toward shorter values, which allows processors to tune emitters to match the absorption spectrum of food.

54. (C) Water
Water is the primary food component that dictates the absorption spectrum and efficiency of far-infrared radiation. Liquid water molecules exhibit strong vibrational and rotational absorption bands within the far-infrared region, leading to highly efficient energy coupling and rapid surface temperature increases during the drying or pasteurization of high-moisture foods.

55. (D) Far-infrared (long-wave) emitter
Ceramic heater elements operate at relatively low temperatures, making them typical examples of far-infrared emitters. These long-wave emitters produce radiation that is highly absorbed by water and organic components at the food surface, rendering them ideal for uniform surface drying and dehydration tasks in various processing setups.

56. (A) Heat is generated internally via resistance as AC passes through the milk.
Ohmic heating generates heat internally within liquid milk as alternating electrical current passes through it. The resistance of the food matrix to the electric current converts electrical energy directly into thermal energy via the Joule effect, providing rapid, volumetric heating without relying on hot solid heat-exchanger surfaces.

57. (B) The heating rate is inversely proportional to the square of the electric field strength.
In ohmic heating, the volumetric heating rate is directly proportional to the square of the applied electric field strength, rather than being inversely proportional. Increasing the voltage gradient across the electrodes significantly accelerates heat generation, which is also influenced by the

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and distinction between the liquid phase and gas phase completely disappear. The resulting fluid exhibits liquid-like density and gas-like viscosity, merging properties of both states of matter.

137. (B) It leaves no solvent residue in the product after depressurization.
Using supercritical carbon dioxide for lipid extraction in dairy systems offers a major advantage over organic solvents like hexane. Upon depressurization, carbon dioxide returns completely to its gaseous state, leaving zero toxic solvent residues in the product. This eliminates costly separation steps, yields a pure lipid extract, and aligns with clean-label and organic processing requirements.

138. (B) The endpoint of the liquid-gas curve, where separate liquid and gas phases cease to exist
In a thermodynamic phase diagram, the critical point is defined as the termination point of the liquid-gas vapor pressure curve. Beyond this specific temperature and pressure, the densities of the coexisting liquid and gas phases become identical, making them indistinguishable, and the substance behaves as a single-phase supercritical fluid with unique transport properties.

139. (A) 31.1°C and 7.38 MPa (73.8 bar)
Carbon dioxide exhibits highly favorable thermodynamic properties for industrial extraction because it has a relatively low critical temperature of thirty-one point one degrees Celsius and a critical pressure of seven point three eight megapascals. These mild critical parameters allow processing to occur at low temperatures, preventing thermal degradation of heat-sensitive dairy lipids and bioactive compounds.

140. (A) Both (A) and (R) are true and (R) is the correct explanation of (A).
Supercritical fluids are exceptionally effective solvents because they possess unique hybrid transport properties. Their liquid-like densities provide high solvating power to dissolve target solutes, while their gas-like viscosities and high diffusivities enable rapid mass transfer and deep penetration into complex solid matrices, thereby facilitating highly efficient extraction processes compared to conventional liquid solvents.

141. (D) Near the critical point, small changes in temperature or pressure yield large changes in density and solvent power.
The thermodynamic behavior of supercritical fluids near their critical point is highly sensitive. Small adjustments in temperature or pressure result in massive shifts in density, directly altering the fluid's solvating power. This property allows processors to highly tune extraction selectivity and easily separate target compounds by slightly modifying system conditions during the extraction cycle.

142. (C) Below the critical pressure, the fluid remains in a true supercritical state regardless of temperature.
A substance can only achieve a true supercritical state when both its temperature and pressure are maintained above its critical values. If the pressure falls below the critical threshold, the fluid cannot be supercritical, returning to either a liquid or gas phase depending on temperature, though co-solvents like ethanol can be added to alter overall polarity.

143. (B) Density – Similar to a liquid
In supercritical fluid extraction, different physical properties resemble different states of matter. The density of a supercritical fluid is high and closely resembles that of a liquid, giving it excellent solvating capacity. In contrast, its viscosity and diffusivity are closer to those of gases, allowing rapid penetration and fast mass transfer through the extraction bed.

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144. (D) Supercritical region – The area below critical pressure and above critical temperature
The supercritical region on a phase diagram is strictly located above both the critical pressure and critical temperature. Any region below the critical pressure belongs to either the gas, liquid, or solid phases. Understanding these phase boundaries is essential for designing extraction systems and optimizing parameters like pressure and temperature to ensure efficient solvation.

145. (A) It is highly polar and excellent at extracting hydrophilic proteins.
Supercritical carbon dioxide is non-polar, making it highly effective for extracting hydrophobic compounds like lipids and oils, but poor at dissolving polar proteins or sugars unless co-solvents are added. Its popularity stems from being non-flammable, inexpensive,

microbial growth and chemical degradation, without requiring high temperatures that damage nutrients, flavor, or texture.

200. (C) P-2, Q-1, R-4, S-3
Space food preservation technologies utilize distinct processing principles. Lyophilization involves freezing and vacuum sublimation of ice. Thermostabilization applies high heat to sealed pouches to achieve commercial sterility. Irradiated foods are sterilized using ionizing radiation to destroy pathogens. Intermediate moisture processing utilizes humectants to lower water activity while maintaining a soft texture.

201. (B) Thermostabilized foods retain moisture and are ready-to-eat, while freeze-dried foods require rehydration.
Thermostabilized space foods undergo thermal sterilization in sealed pouches, retaining their natural moisture content and remaining ready to eat directly from the package. Conversely, freeze-dried space foods have almost all moisture removed to reduce weight, necessitating liquid reconstitution with water aboard the spacecraft before they can be consumed by astronauts.

202. (B) A sealed pouch featuring a one-way valve and straw
Consuming liquids in a microgravity space environment requires specialized packaging to prevent fluids from floating away. A sealed pouch equipped with a one-way valve and straw is utilized, allowing astronauts to squeeze the liquid directly into their mouths without exposing the fluid to the cabin, thereby preventing messy floating liquid droplets.

203. (A) Launching payload into orbit is astronomically expensive per kilogram.
Minimizing the mass and physical volume of space foods is a critical engineering priority because launching payload into Earth orbit requires massive amounts of rocket fuel, making transport costs extremely high per kilogram. Reducing food weight through technologies like freeze-drying directly lowers mission expenses and maximizes the available cargo capacity.

204. (A) Traditional dietetics
Molecular nutrition supplements traditional dietetics by providing a deeper, gene-level understanding of how specific dietary components interact with human physiology. While traditional dietetics focuses on macro-nutrient and micro-nutrient intake to maintain health, molecular nutrition explores these relationships at the molecular level, enabling personalized dietary recommendations based on genetic profiles.

205. (D) It profiles low-molecular-weight compounds to characterize cheese ripening and detect adulteration.
Applying metabolomics in dairy science provides a key analytical advantage by profiling the complete set of low-molecular-weight metabolites in a sample. This allows researchers to monitor chemical changes during cheese ripening, identify geographical origin biomarkers, and detect subtle adulteration by revealing anomalous metabolic patterns that traditional testing methods might miss.

206. (C) Studying how dietary components and the genome interact to affect gene expression and regulation.
In food science, nutrigenomics is defined as the study of how dietary components and nutrients interact with the genome to influence gene expression, protein translation, and metabolic regulation. This field aims to explain how specific food molecules can alter cellular pathways, providing a scientific basis for developing personalized nutrition plans and functional foods.

207. (B) Active cellular transcriptomics
The specific omic technology that monitors the large-scale expression of all ribonucleic acid transcripts produced by a genome under specific environmental conditions is transcriptomics. By analyzing the transcriptome, scientists can determine which genes are active, upregulated, or downregulated in starter cultures or probiotic bacteria during manufacturing stresses like heat or acidity.

208. (D) It monitors stress-response protein up-regulation in starter cultures under acid or heat shock.
In dairy science, proteomics involves the comprehensive analysis of all proteins expressed by a biological system at a given time. This technology is highly valuable for monitoring how lactic acid bacteria upregulate specific stress-response and chaperone proteins under environmental challenges, helping researchers

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its economic viability to high-value ingredients rather than low-cost bulk dairy products.

155. (A) Separating complex lipid mixtures into fractions of different solubility and physical properties
In supercritical processing, fractionation refers to the physical separation of a complex lipid mixture into multiple distinct fractions that possess different solubilities, molecular weights, and melting characteristics. This process does not chemically modify or break down the triglyceride molecules, but rather groups them physically to achieve specific functional properties in food formulations.

156. (C) β-galactosidase
The enzyme lactase, which is widely utilized throughout the commercial dairy industry to produce lactose-free products, is scientifically classified as beta-galactosidase. This enzyme catalyzes the hydrolysis of the disaccharide lactose, cleaving the beta-one-four glycosidic bond to yield two simpler, sweeter monosaccharides, namely glucose and galactose, which are easily digested by lactose-intolerant consumers.

157. (D) Kluyveromyces lactis
Neutral lactase enzymes used for treating fluid milk are commercially produced from the yeast Kluyveromyces lactis. This organism yields an enzyme with a neutral optimal pH, which is highly compatible with the natural pH of sweet liquid milk, whereas fungal sources like Aspergillus niger produce acidic lactases that are better suited for processing acidic whey streams.

158. (C) It cross-links proteins via covalent bonds between glutamine and lysine residues.
Transglutaminase is a specialized structuring enzyme used in dairy processing that catalyzes the formation of covalent isopeptide bonds between the acyl group of a glutamine residue and the primary amine group of a lysine residue. This cross-linking modifies protein structures, significantly improving gel strength, water-holding capacity, and viscosity in fermented dairy products.

159. (B) It forms highly insoluble polymers that precipitate out of the milk.
Commercial lactase application hydrolyzes lactose into soluble glucose and galactose, increasing sweetness and reducing crystallization in frozen dairy foods without forming insoluble polymers. This enzymatic reaction keeps the sugars fully dissolved, helping to prevent the sandy texture defect in ice cream and condensed milk caused by large, sharp lactose crystals.

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160. (D) I, II and III
Different enzymes provide specific benefits in dairy systems. Transglutaminase cross-links milk proteins, enhancing viscosity and preventing syneresis in yogurt. Fungal lactases from Aspergillus species operate efficiently in acidic environments, ideal for acid whey. Cold-active lactases retain catalytic activity at low temperatures, enabling lactose hydrolysis to occur slowly during refrigerated transport or storage.

161. (A) Glucose oxidase – Coagulation of casein micelles to form hard cheese curd
Coagulation of casein micelles to form cheese curd is achieved by rennet enzymes like chymosin, not glucose oxidase. Glucose oxidase is used for oxygen scavenging and antimicrobial applications. Other enzymes are correctly matched: beta-galactosidase prevents lactose crystallization, transglutaminase reduces syneresis in set yogurt, and lysozyme prevents late-blowing defects by inhibiting gas-producing Clostridia.

162. (C) Accelerated degradation of lactose into lactic acid
Treating cheese milk with transglutaminase cross-links proteins, which increases moisture retention, curd firmness, and overall yield by trapping whey proteins within the casein matrix. However, this enzyme has no biochemical role in carbohydrate metabolism and does not affect the conversion of lactose into lactic acid, which is driven by starter cultures.

163. (A) Michaelis-Menten kinetics with galactose product inhibition
The enzymatic hydrolysis of lactose by beta-galactosidase is mathematically described using Michaelis-Menten kinetics, incorporating a term for product inhibition by galactose. As the reaction proceeds, the accumulation of galactose competitively inhibits the enzyme, slowing down the hydrolysis rate, which must be factored into industrial reactor designs for lactose-free milk production.

164. (D) Isopeptide bonds form to create a stronger, more cross-linked three-dimensional network.
Applying transglutaminase to milk before yogurt fermentation cross-links the protein structure by creating covalent isopeptide bonds between glutamine and lysine residues. This modifies the protein matrix, forming a highly stable, three-dimensional network that traps water more effectively, increases gel firmness, and significantly reduces syneresis during storage of the final set yogurt.

165. (B) Hydrolysis of low-sweetness lactose into sweeter glucose and galactose.
The increase in perceived sweetness in lactose-hydrolyzed milk is caused by the chemical breakdown of lactose. Lactose possesses relatively low relative sweetness compared to sucrose. Hydrolyzing it yields equal parts glucose and galactose, which have significantly higher sweetness indexes. This allows processors to formulate sweeter dairy products without adding sucrose or artificial sweeteners.

166. (C) Esterases that cleave triglyceride ester bonds
Exogenous lipases utilized during cheese ripening are biochemically classified as esterases. These enzymes specifically target and hydrolyze the ester bonds linking fatty acids to the glycerol backbone of triglycerides. This activity releases free fatty acids of various chain lengths, which serve as crucial precursors for the development of characteristic sharp flavors in mature cheeses.

167. (D) FPC offers high specificity for κ-casein cleavage but is produced by genetically modified microbes.
Fermentation-produced chymosin is an exceptionally pure coagulating enzyme synthesized by genetically modified micro-organisms. It offers extremely high specificity for cleaving the phenylalanine-one-hundred-and-five to methionine-one-hundred-and-six peptide bond of kappa-casein, identical to traditional calf rennet, while avoiding the non-specific proteolysis often associated with crude animal rennets or some microbial coagulants.

168. (A) The specific color of the cheese wax coating
The catalytic efficacy of exogenous proteases added to accelerate cheese ripening is governed by physical and chemical factors like curd moisture, water activity, ripening temperature, and cheese pH. These parameters dictate enzyme stability and reaction kinetics. Conversely, the color of the external wax coating is a cosmetic package feature that has no impact on proteolysis.

169. (B) They are designed to lyse and release peptidases into the curd without producing excess acid.
Attenuated starter cultures are cells that have been treated to prevent growth and acid production while keeping their intracellular enzymes active. When added during cheesemaking, these cells undergo rapid lysis, releasing intracellular peptidases and esterases into the curd. This enhances proteolysis and flavor development during ripening without causing excessive acidification or structural defects.

170. (B) I, II and III
In cheese ripening, excessive proteolysis from broad-spectrum enzymes often generates bitter peptides. Pregastric esterases release specific fatty acids that create the piquant flavor of Italian cheeses. Recombinant chymosin matches the genetic sequence of calf chymosin. Lipases, however, break down lipids into free fatty acids, whereas proteases are responsible for breaking down proteins into amino acids.

171. (A) Most enzymes are lost in the whey during draining, reducing efficiency and contaminating the whey bypass.
Adding free, unencapsulated enzymes directly to cheese milk is highly inefficient because a large majority of the active enzymes remain partitioned in the liquid whey phase during draining. This results in significant economic loss, poor enzymatic retention in the target curd, and undesirable contamination of the whey bypass stream, which limits its subsequent processing options.

172. (C) Entrapping enzymes in liposomes or polymers to ensure retention in the curd rather than loss in whey.
Microencapsulation in cheesemaking involves entrapping active ripening enzymes within protective lipid bilayers, like liposomes, or biodegradable polymers. This physical barrier ensures that the enzymes remain sequestered within the developing curd during coagulation and draining, preventing their loss in the whey. The capsules subsequently break down during

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ripening, releasing enzymes to accelerate flavor development.

173. (D) The Phenylalanine-105 and Methionine-106 peptide bond of κ-casein
Chymosin is a highly specific aspartic protease whose primary function is initiating milk coagulation. It achieves this by selectively cleaving a single, specific peptide bond located between the phenylalanine-one-hundred-and-five and methionine-one-hundred-and-six residues of kappa-casein. This cleavage destabilizes the protective hairy layer of the micelle, causing rapid aggregation in the presence of calcium.

174. (C) Aspergillus niger var. awamori or Kluyveromyces lactis
Fermentation-produced chymosin is commercially manufactured using genetically modified industrial host strains, primarily the fungus Aspergillus niger variety awamori, or the yeast Kluyveromyces lactis. These safe host organisms are engineered to express the bovine chymosin gene, allowing high-yield secretion of pure, highly specific chymosin enzymes that are subsequently purified for vegetarian-friendly cheesemaking.

175. (B) It releases short-chain free fatty acids (e.g., butyric, caproic) to develop sharp, mature flavors.
Using exogenous lipases accelerates cheese ripening by targeting milk fat. These enzymes hydrolyze triglycerides, specifically releasing short-chain and medium-chain free fatty acids like butyric, caproic, caprylic, and capric acids. These volatile fatty acids are directly responsible for producing the characteristic sharp, piquant, and mature flavor profiles found in premium aged cheese varieties.

176. (D) Synthetic food colors are allowed if the base milk is organic.
Organic food processing guidelines under the National Programme for Organic Production strictly prohibit the use of synthetic food colors, chemical preservatives, and ionizing radiation, regardless of the organic status of the base milk. All processing aids, additives, and ingredients must be explicitly approved, and genetically modified organisms are completely banned from all organic production systems.

177. (A) NPOP – The primary regulatory framework for organic production in India
The National Programme for Organic Production is the primary regulatory framework that governs organic agricultural production, processing, and certification in India. It establishes strict standards for organic labeling, crop production, and livestock management, ensuring that certified organic foods comply with national and international quality and trace environmental guidelines.

178. (C) High-dose gamma irradiation – Allowed for sterilizing organic milk packaging
Under organic standards, high-dose gamma irradiation is strictly prohibited for treating any organic food or its primary packaging materials. Other regulations are correctly represented: recombinant chymosin is banned due to its genetically modified origin, synthetic preservatives are strictly prohibited, and natural, non-genetically modified microbial rennet is fully allowed for organic cheesemaking.

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179. (A) Treatment with synthetic fungicidal washes
Processing certified organic liquid milk allows physical and mechanical operations like thermal pasteurization, homogenization, and centrifugal fat separation, as these do not introduce synthetic chemicals. However, treating the milk or the equipment with synthetic chemical fungicidal washes is strictly prohibited, as organic standards mandate natural sanitization and raw material purity.

180. (B) III and V
Organic regulations forbid nanotechnology applications in food packaging and do not automatically approve natural flavors without verifying extraction solvents. Conversely, equipment must be cleaned to prevent commingling conventional and organic milk, agricultural ingredients must be certified organic, and boiler water additives must not contact organic products unless specifically permitted under NPOP guidelines.

181. (B) A documented, complete cleaning cycle must occur before the organic run to prevent commingling.
When conventional and organic milk are processed on the same industrial equipment, organic regulations mandate that a fully documented, complete sanitation and cleaning

218. (B) Untargeted metabolomics scans entire profiles for anomalies, while targeted metabolomics quantifies predefined targets.
Untargeted metabolomics scans the complete chemical profile of a sample to detect unknown compounds and overall composition variations, making it ideal for detecting unexpected adulterants. In contrast, targeted metabolomics focuses on measuring and quantifying a predefined group of known chemical markers, requiring specific reference standards to achieve precise absolute quantitation.

219. (A) The color of the laboratory walls
Proteomic analysis of cheese ripening is influenced by critical variables like active enzymes, extraction protocols, ripening time, and storage temperature. These parameters determine peptide production and overall analytical recovery. Conversely, environmental factors like the color of the laboratory walls have absolutely no physical or chemical impact on the analysis.

220. (C) P-3, Q-1, R-4, S-2
Analytical methods are matched to specific applications. Nuclear magnetic resonance spectroscopy provides non-destructive, highly reproducible metabolite analysis. Two-dimensional gel electrophoresis separates complex protein mixtures by isoelectric point and molecular weight. Principal component analysis is a statistical tool used to identify patterns in big data. RNA sequencing profiles the transcriptome of lactic acid bacteria.

221. (D) Human sensory evaluation panels
Volatile metabolomics, or flavoromics, acts as a highly sensitive chemical supplement to human sensory panels. While human panels are essential for evaluating overall product acceptability and taste perception, flavoromics provides an objective, highly reproducible chemical analysis of the specific volatile organic compounds that contribute to cheese flavor, reducing subjective variation in quality control.

222. (C) It details specific stress mechanisms and metabolic states of cells rather than just counting survivors.
Using transcriptomics to evaluate starter culture health offers a major advantage over simple plate counting because it provides detailed information about active cellular stress pathways and metabolic states. While plate counting only enumerates viable survivors, transcriptomic analysis reveals how cells adapt, survive, or experience sublethal injury during harsh dairy manufacturing processes.

223. (B) A measurable molecule whose concentration indicates a specific physiological state, origin, or history.
In food metabolomics, a biomarker is defined as a specific, measurable molecule or metabolite whose concentration serves as an objective indicator of a biological process, physiological state, geographic origin, or processing history. Detecting these unique molecular markers allows scientists to verify product authenticity, trace food sources, and monitor quality changes.

224. (D) Messenger RNA (mRNA)
The biological molecule that directly links genetic information stored in the genome to the functional molecules in the proteome is messenger ribonucleic acid. Through transcription, DNA sequences are copied into messenger RNA, which is then translated by ribosomes into active proteins, making it the central target for transcriptomic studies.

225. (A) Identifying IgE-binding epitopes on allergens like β-lactoglobulin to design hypoallergenic processes.
In addressing dairy allergies, proteomics is applied to identify and map the specific immunoglobulin-E binding epitopes on major milk allergens, such as beta-lactoglobulin and alpha-lactalbumin. This molecular mapping enables researchers to design targeted enzymatic, thermal, or physical processing methods to modify these structures, helping produce safer, hypoallergenic dairy products.

226. (C) Heat shock triggers chaperone protein (e.g., GroEL) up-regulation to avoid misfolding, seen via proteomics.
When lactic acid bacteria experience sudden heat shock, they upregulate molecular chaperone proteins like GroEL and DnaK to prevent cellular protein misfolding and aggregation. This stress response can be monitored using proteomic techniques, which detect changes in the cellular protein profile, helping scientists select robust starter cultures for high-temperature dairy processing.

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organisms, leaving the final enzyme preparation free of detectable genetically modified DNA or host cells, meaning no bioengineered material remains in the finished cheese.

191. (B) Production of recombinant bovine somatotropin to increase milk yield in dairy cows
A prominent application of recombinant DNA technology in the dairy industry is the commercial production of recombinant bovine somatotropin. This bioengineered hormone, synthesized by genetically modified bacteria, is administered to dairy cows to stimulate milk production, significantly increasing daily yields, though its utilization remains subject to varying regional regulations and public acceptance.

192. (D) FSSAI mandates labeling for foods with GM DNA or protein content above a specific threshold.
The Food Safety and Standards Authority of India establishes specific labeling regulations for genetically modified foods. These guidelines mandate clear front-of-pack labeling for food products containing genetically modified ingredients or recombinant DNA and proteins once their concentration exceeds a designated threshold, ensuring consumer transparency and informed food purchasing decisions in India.

193. (A) Transfer of antibiotic resistance marker genes to gut microflora is not considered a risk and is never evaluated.
During safety assessments of genetically modified foods, regulators thoroughly evaluate potential allergenicity, toxicity, and unintended compositional changes to ensure substantial equivalence. The horizontal transfer of antibiotic resistance marker genes to human gut microflora is recognized as a potential risk, and safety agencies systematically evaluate it to prevent the spread of clinical resistance.

194. (C) Substantial equivalence – Treating a GM food as safe if it is compositionally identical to an existing food
Substantial equivalence is a key regulatory concept used to assess the safety of genetically modified foods. It states that if a bioengineered food is shown to be compositionally and nutritionally identical to its conventional counterpart, it can be treated as safe, establishing a baseline for evaluating potential allergenicity, toxicity, and unexpected nutritional modifications.

195. (A) Intermediate moisture foods – Addition of large amounts of free water to enhance shelf life
Intermediate moisture foods are processed to lower water activity using humectants and mild dehydration, not by adding water, which would accelerate spoilage. Other space food technologies are correctly matched: freeze-drying sublimates ice under vacuum, thermostabilization sterilizes food inside retort pouches, and zero-gravity packaging uses valves and straws to contain liquids.

196. (D) It must rely exclusively on heavy glass jars for absolute barrier protection.
Space food packaging must minimize mass and volume, resist pressure changes, provide a barrier against oxygen and moisture, and prevent the release of crumbs or liquids in microgravity. Relying on heavy glass jars is avoided because glass adds excessive payload weight and poses a high risk of shattering, creating dangerous floating debris.

197. (B) Loose particles can float in microgravity, posing an inhalation hazard and risking sensitive equipment damage.
Dry, crumbly cheeses and loose powders are strictly avoided on space missions because of the microgravity environment. Without gravity, loose food crumbs and powder particles float freely throughout the spacecraft cabin, where they can be inhaled by astronauts, cause eye irritation, or drift into sensitive electronic controls, posing serious safety hazards.

198. (C) Lowering water activity (a_w) to 0.6–0.85 using humectants to inhibit microbes without full dehydration.
Intermediate moisture foods for space flight rely on maintaining a water activity between point six and point eight-five. This is achieved by adding humectants like salt, sugar, or glycerol to bind free water. This level inhibits microbial growth while keeping the food soft and ready to eat, eliminating the need for liquid reconstitution.

199. (D) Moisture removal via sublimation, lowering water activity below the threshold for microbial and chemical decay.
The extended shelf life of freeze-dried space foods is due to the sublimation of ice from the frozen product under vacuum. This physical process removes almost all free water, lowering water activity below the threshold required for

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generally recognized as safe, and having a low critical temperature that protects heat-sensitive compounds from thermal damage.

146. (C) Fractionation of anhydrous milk fat to isolate specific triglyceride melting fractions
In the dairy industry, supercritical fluid extraction is most appropriately applied to the fractionation of anhydrous milk fat. By systematically adjusting extraction pressures and temperatures, processors can separate milk fat into distinct fractions based on triglyceride molecular weight and melting points, creating customized lipids with specific melting profiles for baking or spreading applications.

147. (A) Add a polar co-solvent, such as ethanol or water, to the SC-CO_2
Because pure supercritical carbon dioxide is inherently non-polar, it cannot dissolve polar substances like bioactive peptides. To extract these compounds, a small amount of a polar co-solvent, or entrainer, such as ethanol or water must be added. This modification alters the overall polarity of the fluid phase, enabling the extraction of hydrophilic target molecules.

148. (D) Selective solubility of cholesterol in SC-CO_2 at optimized temperature and pressure
Reducing cholesterol in butter oil using supercritical carbon dioxide relies on the selective solubility of cholesterol compared to triglycerides. By optimizing extraction temperature and pressure, carbon dioxide can solubilize cholesterol molecules, allowing them to be separated and removed from the fat matrix without degrading the natural triglycerides or altering the nutritional quality of the milk fat.

149. (B) Differences in lipid molecular weight, polarity, and solubility in the dense gas
Fractionation of milk lipids using supercritical fluids is a separation process driven by differences in molecular weight, structure, polarity, and solubility of individual triglycerides within the dense gas phase. By stepwise changes in pressure and temperature, the density of carbon dioxide is adjusted, allowing different lipid fractions to precipitate sequentially according to their physical and chemical properties.

150. (B) P-2, Q-4, R-1, S-3
Supercritical fluid extraction processes use specific mechanisms for different dairy applications. Cholesterol reduction relies on tuning pressure to target sterol solubility. Bioactive lipid extraction avoids thermal degradation of polyunsaturated fatty acids. Milk fat fractionation separates triglycerides of varying melting points via stepwise depressurization. Adding polar entrainers like ethanol enables the extraction of polar lipids from dairy byproducts.

NODIA

151. (D) The ambient atmospheric pressure in the processing plant
The efficiency of continuous cholesterol removal from liquid milk fat depends on internal system parameters like carbon dioxide flow rate, temperature, pressure inside the extraction column, and contact surface area. Conversely, the ambient atmospheric pressure outside the processing facility has no impact on these high-pressure operations, which are fully contained within heavy steel vessels.

152. (A) Create spreadable butter straight from the fridge
Using supercritical carbon dioxide to fractionate butter fat yields distinct lipid fractions with high-melting and low-melting points. Recombining these fractions allows manufacturers to formulate specialty butter products that remain soft and easily spreadable even at refrigerated temperatures, without requiring chemical hydrogenation or generating undesirable trans-fatty acids during the modification process.

153. (B) Partial hydrogenation
Supercritical fluid extraction provides a physical fractionation method that effectively replaces partial chemical hydrogenation for modifying dairy fat profiles. Unlike partial hydrogenation, which chemically alters fatty acids and produces harmful trans-fats, supercritical fractionation physically separates existing triglycerides based on solubility, creating healthy, customized melting profiles without generating artificial trans-isomers.

154. (B) It requires high capital investment for high-pressure equipment.
The primary disadvantage of implementing supercritical fluid extraction on an industrial scale is the very high initial capital investment required. The process operates under extreme pressures, necessitating thick-walled stainless steel extraction vessels, high-pressure pumps, and complex control systems, which can limit

optimize culture viability during drying and fermentation.

209. (A) Mapping specific metabolite profiles (biomarkers) to differentiate organic from conventional milk.
Metabolomics is a powerful tool for milk traceability because it maps unique metabolite profiles, or biomarkers, in dairy samples. These chemical fingerprints reflect the cow's diet, health, and environment, enabling scientists to clearly differentiate organic milk from conventional milk and verify geographic origin, protecting consumers from fraudulent labeling.

210. (A) II, IV, I, III
The standard mass spectrometry-based metabolomics workflow starts with sample extraction and chemical derivatization to stabilize volatile components. The extract is then separated using gas or liquid chromatography and analyzed by mass spectrometry. Finally, multivariate statistical analysis identifies unique molecular patterns, leading to the confirmation of significant biomarkers of cheese ripening.

211. (A) Proteomics – The complement of proteins expressed by a starter culture at a given time
Proteomics is correctly matched to studying the complete set of proteins expressed by a cell at any given moment under specific conditions. Other terms are mismatched: transcriptomics measures dynamic messenger RNA transcripts, genomics determines static DNA sequences, and metabolomics profiles the low-molecular-weight metabolites, lipids, and volatile organic compounds.

212. (D) Bioactive peptides – Up-regulation of ACE to purposefully cause hypertension
Bioactive dairy peptides do not cause hypertension; rather, they are studied for down-regulating or inhibiting angiotensin-converting enzyme to help lower blood pressure. Other matches are correct: conjugated linoleic acid modulates lipid metabolism genes, calcium and vitamin D regulate bone mineralization pathways, and butyrate epigenetically regulates cell cycles via histone deacetylase inhibition.

213. (B) Simple glass thermometers
Modern metabolomics profiling relies on high-throughput analytical instruments like nuclear magnetic resonance spectroscopy, gas chromatography-mass spectrometry, and liquid chromatography-mass spectrometry to detect and quantify thousands of small metabolites. Conversely, simple glass thermometers are basic physical instruments used for temperature measurement and have no role in chemical metabolite profiling.

214. (C) Identifying which specific genes are expressed or repressed under thermal and osmotic drying stress.
Applying transcriptomics to study probiotics during spray drying allows researchers to identify which specific genes are active or silenced in response to heat and osmotic stress. This molecular information reveals the cell's survival mechanisms, helping scientists optimize processing parameters or formulate protective media to improve probiotic viability.

215. (D) Nutrigenomics
A discovery showing that a novel bioactive peptide in whey can alter human inflammatory gene expression pathways falls directly under the field of nutrigenomics. This science examines how specific food molecules interact with human genes to modify biological pathways, helping explain how functional dairy ingredients can promote health or prevent chronic inflammation.

216. (A) Simultaneous profiling of thousands of molecules that fluctuate based on processing.
The massive data complexity in proteomic and metabolomic studies is driven by the simultaneous profiling of thousands of distinct molecules, including proteins, peptides, and metabolites, that change in response to processing conditions. Analyzing these extensive datasets requires advanced bioinformatics, high-performance computing, and specialized multivariate statistical tools to identify meaningful biological patterns.

217. (B) Genomics
Identifying an exact point mutation in the genetic material of a bacteriophage that infects dairy starter cultures is classified as genomics. This field focuses on the structural sequence and variation of DNA or RNA in organisms, helping researchers understand viral infectivity, design resistant starter strains, and prevent fermentation failures in cheese factories.

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cycle must occur before the organic run. This procedure is essential to prevent the physical commingling or cross-contamination of organic milk with conventional milk residues, maintaining the integrity of organic certification.

182. (C) Hexane is a petroleum-derived solvent that conflicts with organic natural processing standards.
The strict prohibition of solvents like hexane in organic processing is because they are petroleum-derived synthetic chemicals. Organic standards require processing methods to rely on physical extraction or natural, non-synthetic solvents like water, carbon dioxide, or ethanol, thereby avoiding chemical residues and aligning with sustainable, natural manufacturing principles.

183. (D) The exact weight percentage of organic ingredients, excluding water and salt
Organic labeling classifications are based on the exact weight percentage of certified organic agricultural ingredients contained within the product, excluding added water and salt. Products must meet precise numeric thresholds, such as ninety-five percent for organic labeling, to ensure transparent marketing and help consumers identify the actual concentration of organic materials.

184. (A) Formally listed on the national allowed substances list for organic processing
Any processing aid utilized in organic dairy manufacturing must be formally listed on the national allowed substances list. This register specifies which non-organic substances and processing aids are permitted, ensuring they do not contain synthetic chemicals, genetically modified derivatives, or toxic residues, thereby preserving the organic integrity of the finished dairy product.

185. (B) The brand of office computers used by the management
During an organic audit of a dairy plant, certification bodies focus on critical compliance parameters like organic traceability documents, pest control protocols, and the cleaning chemicals used on food-contact surfaces. These factors directly affect organic integrity. Conversely, administrative details like the brand of office computers are completely irrelevant to organic regulatory compliance.

186. (B) Recombinant DNA technology allows precise enhancement of phage resistance or ripening in dairy cultures.
The utilization of genetically modified starter cultures demonstrates that recombinant DNA technology can precisely introduce desirable traits into dairy bacteria. This includes enhancing resistance against destructive bacteriophages, accelerating ripening through elevated peptidase expression, or improving texturizing capabilities, offering functional advantages over traditional wild-type strains that rely on slow, natural mutation processes.

187. (A) Recombinant DNA and live host cells
When an enzyme produced by a genetically modified micro-organism is highly purified for use, the purification process completely removes all recombinant DNA and live host cells from the preparation. Consequently, the final food ingredient contains only the active enzyme protein, leaving no residual genetically modified biological material in the finished dairy product.

NODIA

188. (C) They face regulatory hurdles, mandatory GM labeling, and low consumer acceptance.
Utilizing live genetically modified starter cultures in food products presents significant commercial disadvantages, mainly due to strict regulatory approval hurdles, mandatory GMO labeling laws in many jurisdictions, and low consumer acceptance of live bioengineered organisms in foods, which can severely limit the marketability of products like bioengineered yogurts.

189. (D) Food containing or produced from genetically modified organisms, regardless of residual GMO content
The Food Safety and Standards Authority of India defines a genetically modified food as any food item containing, consisting of, or produced from genetically modified organisms. This legal definition applies regardless of whether detectable recombinant DNA or proteins remain in the final retail product, thereby covering both live cultures and highly purified processing aids.

190. (A) Both (A) and (R) are true and (R) is the correct explanation of (A).
Purified fermentation-produced chymosin does not typically require GMO labeling on retail cheese packages in many jurisdictions because it functions as a processing aid. The purification process successfully removes all production

227. (A) It has definitively proven that all processed foods are completely sterile.
Applying systems biology to food science enables predictive modeling of shelf life and provides a holistic view of fermentation pathways through computational analysis. However, it does not prove that all processed foods are sterile. Many processed items, such as yogurts and cheeses, intentionally contain abundant populations of live, active starter and probiotic bacteria.

228. (D) Lipidomics – Identifying complex changes in triglyceride profiles during the lipolysis of mold-ripened cheeses
Lipidomics is uniquely suited for analyzing lipids in food systems. This specialized field enables researchers to identify complex modifications in triglyceride, phospholipid, and free fatty acid profiles during the intense lipolysis of mold-ripened cheeses. This provides insight into the development of key texture, aroma, and flavor characteristics in aged dairy products.

229. (B) Osmotic stress (high salt) – Up-regulation of completely unrelated photosynthetic pathways
Under osmotic stress, non-photosynthetic lactic acid bacteria upregulate osmoprotectant transport systems, not photosynthetic pathways, which are entirely absent from their genome. Other matches are correct: acid stress induces proton-extruding ATPase, cold shock triggers cold-shock proteins to maintain membrane fluidity, and heat shock induces chaperones and proteases to manage protein misfolding.

230. (C) It completely eliminates the need for humans to consume any macro-nutrients.
Nutrigenomics could revolutionize personalized dairy nutrition by enabling targeted product formulations for individuals with genetic predispositions and clarifying varied health responses based on single nucleotide polymorphisms. However, this science does not eliminate the physical requirement for humans to consume bulk macro-nutrients, which remain essential for providing biological energy and structural building blocks.

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(B) It inherently damages the sample by exposing it to ultraviolet light
(C) Sample preparation can significantly alter native structure
(D) It is only capable of analyzing completely dry powders

2025
51. Which microscopy technique provides the highest theoretical magnification and resolution, ideal for observing individual casein sub-micelles?
(A) Transmission Electron Microscopy (TEM)
(B) Confocal Laser Scanning Microscopy (CLSM)
(C) Light Microscopy
(D) Stereomicroscopy

2016
52. How does Confocal Laser Scanning Microscopy (CLSM) distinguish between the fat and protein phases in a cheese matrix?
(A) By differences in their electrical conductivity
(B) By bombarding the sample with electrons and measuring backscatter
(C) By physically separating the phases before optical imaging
(D) By utilizing specific fluorescent dyes for different phases

2010
53. Which of the following accurately describes a water-in-oil (W/O) dairy emulsion?
(A) Homogenized milk where lipid fat droplets are dispersed uniformly in water
(B) Butter where aqueous droplets are dispersed in milk fat
(C) Ice cream where air bubbles are trapped in a fat matrix
(D) Whey protein isolate dissolved in a dilute buffer

2011
54. What constitutes a "multiple emulsion" in advanced dairy formulations?
(A) A simple mixture of two distinctly different continuous phases
(B) An emulsion strictly containing more than five different emulsifying agents
(C) An emulsion where dispersed droplets contain smaller droplets
(D) A system where fat, protein, and air are all in true solution

2022
55. What physical chemistry principle dictates whether an oil-water mixture will form an O/W or a W/O emulsion based on the emulsifier used?
(A) Stoke's Law
(B) Gibbs Phase Rule
(C) Laplace Equation
(D) Bancroft's Rule

2025
56. According to the Hydrophilic-Lipophilic Balance (HLB) scale, an emulsifier with an HLB value of 4 is most suitable for producing which type of emulsion?
(A) Water-in-oil (W/O) emulsion
(B) Oil-in-water (O/W) emulsion
(C) Stable dairy foams
(D) Clear microemulsions

2004
57. Select the correct sequence of structural destabilization events that typically leads to the visible separation of oil in an O/W dairy emulsion:
I. Coalescence
II. Flocculation
III. Creaming
IV. Phase separation (Oiling off)
(A) II, III, I, IV
(B) III, II, I, IV
(C) II, I, III, IV
(D) I, II, III, IV

2018
58. By what primary mechanism does an added emulsifier reduce the interfacial tension between milk fat and the aqueous phase?
(A) By increasing the bulk viscosity of the continuous phase
(B) By adsorbing at the interface of the two phases
(C) By chemically cross-linking fat globules into a solid network
(D) By hydrolyzing the triglycerides into free fatty acids

2008
59. Which destabilization mechanism involves the migration of dispersed droplets to the top of an emulsion under the influence of gravity or centrifugal force?
(A) Creaming
(B) Coalescence
(C) Ostwald ripening
(D) Flocculation

NODIA

(A) The addition of sucrose causes instantaneous structural buildup that increases shear stress
(B) Disruption of protein aggregates and alignment of asymmetric macromolecules under shear reduces flow resistance
(C) The shear rate is strictly directly proportional to the applied shear stress
(D) Milk fat globules completely dissolve, creating a homogeneous phase

2008

10. Consider the following statements regarding the rheological classification of dairy fluids:
I. Dilatant fluids show an increase in apparent viscosity with increasing shear rate.
II. Bingham plastics require a threshold yield stress to be exceeded before flow initiates.
III. Pseudoplastic fluids exhibit a constant apparent viscosity regardless of shear rate.
Which of the following is the correct combination of statements?
(A) I and II
(B) II and III
(C) I
(D) III

2003

11. Which mathematical equation incorporates a yield stress term and is commonly used to model the flow curve of stirred yogurt?
(A) Herschel-Bulkley equation
(B) Power law equation
(C) Arrhenius equation
(D) Einstein equation

2021

12. In the Power law model $\sigma = K\dot{\gamma}^n$, what does a flow behavior index (n) greater than 1 indicate about a dairy suspension?
(A) The fluid is pseudoplastic
(B) The fluid is perfectly Newtonian
(C) The fluid is dilatant
(D) The fluid is a Bingham plastic

2015

13. Which model is specifically advantageous for analyzing the flow characteristics of molten chocolate and dairy-based chocolate coatings due to its accurate yield stress prediction?
(A) Newtonian model
(B) Laplace equation
(C) Stokes equation
(D) Casson equation

2019

14. What limitation is inherent in using the simple Power law model for characterizing concentrated dairy gels?
(A) It cannot measure temperature fluctuations during the shearing process
(B) It assumes all fluids exhibit perfectly elastic behavior
(C) It inherently lacks a yield stress term for predicting flow initiation
(D) It requires the liquid to be at a boiling state for accurate measurement

2008

15. Analyze the given assertion and reason, and select the correct option.
Assertion (A): Thixotropic dairy fluids display a time-dependent decrease in apparent viscosity under a constant shear rate.
Reason (R): Continuous shear physically disrupts the internal structural network of the dairy matrix over time, leading to reduced resistance to flow.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2012

16. What term describes the rare rheological phenomenon where a dairy fluid shows a time-dependent increase in viscosity under constant shear rate?
(A) Thixotropy
(B) Pseudoplasticity
(C) Viscoplasticity
(D) Rheopexy

2012

17. Which of the following best explains structural recovery in thixotropic dairy products, such as set yogurt, after shear ceases?
(A) Rebuilding of the broken casein micelle network over time
(B) Irreversible syneresis causing rigid and rapid protein precipitation
(C) Immediate and instantaneous restoration of apparent viscosity
(D) Complete separation of the whey from the casein matrix

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CHAPTER 06
Rheology of Dairy Products

2016

1. Which of the following defines the fundamental concept of shear rate in dairy fluids?
(A) The velocity gradient between adjacent flowing fluid layers
(B) The threshold force required to initiate macroscopic gel fracture
(C) The ratio of normal stress to the corresponding normal strain
(D) The internal friction opposing structural breakdown of casein

2024

2. In the context of dairy food rheology, which parameter is characterized by a material's complete recovery to its original shape upon removal of applied stress?
(A) Plasticity
(B) Apparent viscosity
(C) Elasticity
(D) Viscoplasticity

2018

3. What is the fundamental difference between stress and strain in evaluating the texture of a semi-solid dairy product?
(A) Stress is the force applied per unit area, whereas strain is the resulting relative deformation
(B) Strain measures the applied force, whereas stress measures the rate of deformation over time
(C) Stress determines the yield point, whereas strain determines the fluid's kinematic viscosity
(D) Strain is independent of structural integrity, whereas stress indicates irreversible deformation

2015

4. Which rheological property describes the behavior of butter when it retains its shape under gravity but flows when spread with a knife?
(A) Newtonian flow
(B) Ideal elasticity
(C) Dilatancy
(D) Plasticity

2016

5. In rheological terms, what distinguishes a purely viscous dairy liquid from a viscoelastic dairy product?
(A) Purely viscous liquids exhibit delayed structural recovery upon stress removal
(B) Purely viscous liquids dissipate all imparted energy as heat during flow
(C) Viscoelastic products permanently deform instantly upon stress application
(D) Purely viscous liquids store mechanical energy for structural reformation

2016

6. Which statement INCORRECTLY describes the concept of apparent viscosity in dairy fluids?
(A) It represents the direct ratio of shear stress to shear rate under steady flow
(B) It varies continuously with changing shear rates in non-Newtonian fluids
(C) It remains constant across all shear rates for any dairy emulsion
(D) It is an effective measure for characterizing pseudoplastic dairy products

2015

7. Under large deformation testing of cheese, the point at which the internal structure begins to exhibit macroscopic tearing is defined by which specific parameter?
(A) Elastic limit
(B) Yield stress
(C) Loss modulus
(D) Fracture stress

NODIA

2024

8. Based on classification, which of the following best represents a true Newtonian fluid within the dairy industry?
(A) Skim milk
(B) High-fat cream
(C) Whipped butter
(D) Stirred yogurt

2008

9. Why does concentrated sweetened condensed milk typically exhibit pseudoplastic behavior rather than Newtonian behavior?

(B) P-4, Q-3, R-1, S-2
(C) P-1, Q-2, R-3, S-4
(D) P-2, Q-1, R-4, S-3

2016

26. In dynamic oscillatory testing of a hard cheese sample, what does a very low phase angle ($\tan\delta$ near zero) signify?
(A) The material behaves primarily as a purely viscous liquid
(B) The material exhibits strong elastic characteristics
(C) The storage modulus is significantly lower than the loss modulus
(D) The cheese is undergoing rapid syneresis and structural collapse

2018

27. What is the fundamental difference between complex viscosity and apparent viscosity in evaluating dairy gels?
(A) Complex viscosity incorporates both elastic and viscous responses under dynamic testing
(B) Apparent viscosity is measured under dynamic oscillatory conditions, while complex viscosity uses steady shear
(C) Complex viscosity is strictly for Newtonian fluids, while apparent viscosity is for non-Newtonian fluids
(D) Apparent viscosity is derived from the phase angle, whereas complex viscosity relies on yield stress

2010

28. Which measurement technique provides a fundamental rheological property rather than an empirical property of a dairy product?
(A) Using a penetrometer to determine the firmness of butter
(B) Measuring the flow distance of cream on a Bostwick consistometer
(C) Determining storage modulus with a rheometer
(D) Evaluating the cutting resistance of paneer with a wire cutter

2008

29. Why are empirical rheological methods frequently preferred over fundamental methods in commercial dairy plant quality control?
(A) They provide exact SI units of absolute viscosity
(B) They isolate specific fundamental physical properties without interference
(C) They allow for precise measurement of the loss modulus in dilute milks
(D) They are simpler, faster, and correlate well with sensory texture

2006

30. Consider the following statements regarding types of viscometers used in dairy testing:
I. Capillary viscometers measure viscosity based on the time it takes for a fluid to flow through a narrow tube.
II. Falling sphere viscometers are highly suitable for opaque dairy fluids like dense chocolate milk.
III. Rotational coaxial cylinder viscometers can measure shear-dependent apparent viscosity.
IV. Orifice viscometers provide fundamental rheological parameters for pseudoplastic fluids.
V. Falling sphere viscometers rely on Stokes' law for calculating viscosity.
Which of the following is the INCORRECT combination of statements?
(A) II, III and V
(B) I, II and IV
(C) II and IV
(D) II, IV and V

NODIA

2012

31. Which principle governs the operation of a capillary viscometer when evaluating Newtonian dairy liquids?
(A) Stokes' law
(B) Poiseuille's law
(C) Laplace equation
(D) Hooke's law

2024

32. What is a primary limitation of using a falling sphere viscometer for measuring the viscosity of thick dairy creams?
(A) It causes significant structural destruction of the cream's continuous phase
(B) It can only measure fluids at temperatures exceeding 100°C
(C) It inherently operates at extremely high shear rates
(D) It requires the liquid to be entirely transparent to track the sphere

2003

33. In a controlled stress rheometer using a cone-and-plate geometry, what is the main advantage over a parallel plate geometry?
(A) The shear rate is uniform throughout the entire sample volume

2021

18. What is the primary difference between shear-thinning (pseudoplasticity) and thixotropy in dairy foods?

(A) Shear-thinning is strictly time-dependent, whereas thixotropy depends only on the applied shear rate

(B) Shear-thinning requires a yield stress, whereas thixotropy only occurs in Newtonian fluids

(C) Thixotropy is time-dependent, whereas shear-thinning is instantaneous

(D) Thixotropy increases viscosity with shear, whereas shear-thinning decreases it

2001

19. How does generally affect the viscosity of Newtonian dairy fluids like pasteurized skim milk?

(A) Viscosity decreases exponentially as temperature increases

(B) Viscosity increases logarithmically with an increase in temperature

(C) Viscosity remains entirely unaffected by temperature changes

(D) Viscosity fluctuates unpredictably based on the Arrhenius relationship

2005

20. Consider the following statements regarding factors influencing dairy flow behavior:

I. The Arrhenius equation models the effect of temperature on the viscosity of dairy fluids.

II. Previous shear history has no measurable impact on the apparent viscosity of a thixotropic dairy product.

III. Increasing the total solids concentration generally increases the apparent viscosity of dairy dispersions.

IV. Changes in the physical state of milk fat do not influence the rheology of cream.

Which of the following is the correct combination of statements?

(A) I, II and IV

(B) I and III

(C) I, III and IV

(D) II, III and IV

2016

21. Which equation is utilized to estimate the viscosity of a highly dilute dairy suspension containing spherical, non-interacting particles?

(A) Casson equation

(B) Einstein equation

(C) Arrhenius equation

(D) Herschel-Bulkley equation

2023

22. Why must the basic Einstein equation be modified for semi-dilute dairy systems like concentrated skim milk?

(A) Because semi-dilute systems exclusively exhibit extreme dilatant behavior

(B) To remove the influence of temperature variations on the continuous phase

(C) To account for hydrodynamic interactions between protein particles

(D) Because fat globules in semi-dilute systems instantly coalesce

2010

23. What happens to the flow behavior of a dairy suspension as the volume fraction of dispersed particles approaches the maximum packing fraction?

(A) Apparent viscosity drops exponentially to zero due to continuous dilution effects

(B) The system transitions strictly to ideal Newtonian flow

(C) The particles completely dissolve, forming a true solution

(D) Apparent viscosity tends toward infinity, causing solid-like behavior

2014

24. Which factor has the most profound impact on increasing the viscosity of concentrated dairy suspensions aside from volume fraction?

(A) Highly irregular shape of the particles

(B) Decreased particle-particle interaction

(C) Transitioning from non-Newtonian to Newtonian continuous phase

(D) Reduction of the dispersed phase volume

2015

25. Match the dynamic viscoelastic parameters in List I with their correct definitions in List II.

List I: (Dynamic Viscoelastic Parameters)

P. Storage modulus (G')

Q. Loss modulus (G')

R. Complex viscosity

S. Phase angle ($\tan\delta$)

List II: (Definitions)

1. Ratio of viscous to elastic response
2. Total resistance to flow in dynamic testing
3. Measure of energy stored during a deformation cycle
4. Measure of energy dissipated as heat during deformation

(A) P-3, Q-4, R-2, S-1

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2018

42. What does "adhesiveness" represent in the textural evaluation of processed cheese spreads via TPA?
(A) The positive work done during the initial downward compression of the probe
(B) The negative work required to pull the probe away from the cheese surface
(C) The recovery height of the cheese after the probe is fully withdrawn
(D) The force needed to completely fracture the cheese structure

2011

43. Which of the following defines food tribology as applied to dairy products?
(A) The study of friction, wear, and lubrication of foods
(B) The study of thermal degradation of dairy proteins
(C) The measurement of bulk elasticity in hard cheeses
(D) The analysis of microbial growth kinetics in fermented milks

2017

44. In the Stribeck curve, what characterizes the "boundary lubrication" regime?
(A) A thick fluid film completely separates the two sliding surfaces under dynamic flow conditions
(B) Friction is minimal due to high sliding speeds
(C) Direct surface contact where friction depends on surface properties
(D) The coefficient of friction reaches its absolute minimum point

2011

45. Which lubrication regime corresponds to a state where the applied load is fully supported by the hydrodynamic pressure of the dairy fluid film?
(A) Boundary lubrication
(B) Mixed lubrication
(C) Elasto-hydrodynamic lubrication
(D) Hydrodynamic lubrication

2007

46. How does increasing the fat content in milk typically alter its behavior on a Stribeck curve?
(A) It increases the coefficient of friction across all lubrication regimes
(B) It completely eliminates the hydrodynamic lubrication regime
(C) It lowers the coefficient of friction in the mixed lubrication regime
(D) It shifts the boundary lubrication regime to significantly higher sliding speeds

2023

47. Match the sensory perceptions with their associated physical mechanisms.
List I: (Sensory Perceptions)
P. Creaminess
Q. Astringency
R. Firmness
S. Spoonsability
List II: (Physical Mechanisms)
1. Precipitation of salivary proteins causing increased oral friction
2. High loss modulus and moderate yield stress at room temperature
3. High bulk fracture stress under uniaxial compression
4. Reduced coefficient of friction in the mixed lubrication regime
(A) P-1, Q-4, R-2, S-3
(B) P-4, Q-1, R-3, S-2
(C) P-3, Q-2, R-1, S-4
(D) P-2, Q-3, R-4, S-1

2007

48. Why is astringency in whey protein beverages typically associated with increased friction in tribological measurements?
(A) Whey proteins form a highly lubricating hydrodynamic film
(B) Whey proteins increase the bulk viscosity of the beverage to solid-like levels
(C) Whey proteins dissolve oral tissues to reduce friction
(D) Whey proteins denature salivary proteins, breaking the boundary layer

NODIA

2022

49. Which microstructural evaluation technique uses a laser light source and fluorescent dyes to create 3D optical sections of dairy emulsions without physical slicing?
(A) Confocal Laser Scanning Microscopy (CLSM)
(B) Transmission Electron Microscopy (TEM)
(C) Scanning Electron Microscopy (SEM)
(D) Atomic Force Microscopy (AFM)

2017

50. What is a primary limitation of using conventional Scanning Electron Microscopy (SEM) for evaluating the microstructure of fresh yogurt?
(A) It cannot differentiate between proteins and carbohydrates

(C) It increases the bulk density of the cream to prevent creaming
(D) It resists forces that would rupture the bubble lamellae

2006

69. What is the primary driving mechanism for acid-induced gelation in the manufacture of yogurt?
(A) Enzymatic cleavage of kappa-casein removing the hydrophilic macropeptide
(B) Solubilization of colloidal calcium phosphate and reduction of electrostatic repulsion
(C) Thermal denaturation of whey proteins complexing with alpha-lactalbumin
(D) Addition of multivalent cations like calcium to cross-link anionic hydrocolloids

2023

70. Consider the following statements about rennet-induced milk gelation:
I. Chymosin specifically cleaves the Phe105-Met106 bond of kappa-casein.
II. The secondary phase of rennet coagulation involves the aggregation of para-kappa-casein micelles mediated by calcium ions.
III. Rennet gelation primarily occurs at highly alkaline pH levels.
Which of the following is the correct combination of statements?
(A) I and III
(B) II and III
(C) I and II
(D) I

2014

71. How does heat-induced gelation of whey proteins differ fundamentally from rennet-induced gelation of casein?
(A) Heat gelation strictly requires an acidic environment, whereas rennet gelation only occurs at boiling temperatures
(B) Heat gelation involves only the aqueous phase lactose, whereas rennet acts on fat globules
(C) Rennet gelation produces an irreversible covalent network, whereas heat gels are held together solely by weak hydrogen bonds
(D) Heat gelation requires protein unfolding to expose reactive groups, while rennet relies on enzymatic cleavage

2003

72. Which protein interaction is crucial for the increased gel firmness observed when milk is heated prior to yogurt fermentation?
(A) Disulfide binding of beta-lactoglobulin to kappa-casein
(B) Complete biochemical degradation of alpha-casein into free amino acids under heat
(C) Separation of beta-casein into the whey phase
(D) Enzymatic hydrolysis of bovine serum albumin

2011

73. Which of the following is an accurate function of mono- and diglycerides in ice cream manufacturing?
(A) They act solely as sweetening agents
(B) They promote controlled partial coalescence during freezing
(C) They entirely prevent fat globules from interacting with air bubbles
(D) They serve as the primary source of bulk freezing point depression

2015

74. From a chemical classification standpoint, what type of emulsifier is lecithin naturally found in milk and egg yolks?
(A) Synthetic polysorbate
(B) Phospholipid
(C) Sucrose ester
(D) Stearoyl lactylate

2003

75. Analyze the given assertion and reason, and select the correct option.
Assertion (A): Polysorbates (e.g., Tween 80) are highly effective at promoting overrun in ice cream.
Reason (R): They are strongly lipophilic emulsifiers with low HLB values that dissolve entirely in the fat phase without interacting with the aqueous phase.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2014

76. What is the specific role of Sodium Stearoyl Lactylate (SSL) when used in dairy-based bakery fillings?
(A) It exclusively acts as an antimicrobial agent against mold
(B) It artificially colors the filling to mimic butterfat

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2013

60. Analyze the given assertion and reason, and select the correct option.

Assertion (A): Flocculation is generally considered a reversible destabilization process in dairy emulsions.

Reason (R): In flocculation, the aggregated droplets retain their individual interfacial films and can often be redispersed with mild agitation.

(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2016

61. What distinguishes coalescence from flocculation in dairy emulsion stability?

(A) Coalescence involves droplet aggregation without film rupture, while flocculation involves complete membrane merging
(B) Flocculation only occurs in W/O emulsions, whereas coalescence only occurs in O/W emulsions
(C) Coalescence strictly causes downward sedimentation, while flocculation causes upward creaming
(D) Coalescence involves the irreversible merging of droplets into larger ones

2021

62. Which thermodynamic process describes the growth of larger emulsion droplets at the expense of smaller ones due to differences in solubility dictated by droplet curvature?

(A) Gibbs-Marangoni effect
(B) Syneresis
(C) Ostwald ripening
(D) Rheopexy

2023

63. What is the defining characteristic of a dairy foam?

(A) A stable network of aggregated fat globules devoid of any gas
(B) A dispersion of gas bubbles in a continuous liquid phase
(C) A pure liquid phase that exhibits exclusively Newtonian behavior
(D) A system where solid particles are suspended in a gaseous matrix

2010

64. In the production of ice cream, what does the parameter "overrun" mathematically represent?

(A) The percentage increase in weight due to the addition of emulsifiers
(B) The ratio of fat crystals to liquid fat at freezing temperatures
(C) The total volume of water converted to ice crystals
(D) The percentage increase in volume due to air incorporation

NODIA

2021

65. Arrange the following steps in the correct order for the formation of a stable dairy foam during mechanical whipping:

I. Adsorption of proteins to the air-water interface
II. Incorporation of macroscopic air bubbles into the liquid
III. Unfolding and cross-linking of interfacial proteins to form a viscoelastic film
IV. Breakdown of large bubbles into smaller, finely dispersed bubbles

(A) II, IV, I, III
(B) II, I, IV, III
(C) I, II, III, IV
(D) IV, II, I, III

2021

66. Which physical concept describes the pressure difference across the curved surface of a gas bubble in a dairy foam?

(A) Osmotic pressure
(B) Hydrodynamic pressure
(C) Laplace pressure
(D) Bingham yield stress

2024

67. How does the Gibbs-Marangoni effect contribute to the stability of dairy foams?

(A) It stabilizes lamellae via surface tension gradients
(B) It drastically lowers the freezing point of the continuous phase
(C) It induces rapid coalescence of gas bubbles to form a solid matrix
(D) It irreversibly denatures whey proteins, turning the foam into a gel

2023

68. Why is high interfacial rheological elasticity (a strong interfacial film) critical for foam stability in whipped cream?

(A) It ensures the cream will immediately collapse when placed in hot coffee
(B) It prevents any fat crystals from interacting with the air bubbles

(B) It can accommodate much larger particulate matter without jamming
(C) It does not require careful temperature control
(D) It is specifically designed for testing solid cheeses

2018

34. For which type of dairy product is a parallel plate geometry most appropriate to avoid measuring artifacts?
(A) Clarified butter (ghee)
(B) Skim milk
(C) Yogurt containing fruit pieces
(D) Highly dilute whey protein isolates

2017

35. Arrange the following dairy fluids in increasing order of typical apparent viscosity at room temperature and a constant moderate shear rate:
I. Heavy whipping cream
II. Whey
III. Sour cream
IV. Whole milk
(A) II, IV, I, III
(B) IV, II, I, III
(C) II, IV, III, I
(D) IV, II, III, I

2018

36. Which structural parameter determines the fracture stress of a ripened cheese under uniaxial compression?
(A) The volume fraction of the lactose solution
(B) The phase angle of the uncoagulated whey proteins
(C) The kinematic viscosity of the liquid milk fat fraction
(D) The strength of the casein-calcium phosphate network

2006

37. What does the term "yield stress" specifically denote in the context of butter spreadability?
(A) The maximum shear rate the butter can withstand before melting
(B) The minimum force per unit area required to initiate flow
(C) The temperature at which butter fat completely liquefies
(D) The recovery time taken for butter to regain its shape after spreading

2013

38. How does lowering the temperature generally affect the large deformation mechanics of Cheddar cheese?
(A) It reduces both fracture stress and fracture strain, making the cheese highly rubbery
(B) It decreases yield stress, making the cheese flow spontaneously
(C) It increases fracture stress but reduces fracture strain
(D) It completely eliminates the storage modulus, turning the cheese into a fluid

2010

39. In Texture Profile Analysis (TPA) of paneer, how is "hardness" mathematically defined from the resulting force-time curve?
(A) The total area under the first compression peak
(B) The ratio of the positive force areas of the second to the first compression
(C) The distance the sample recovers after the first compression
(D) The peak force recorded during the first compression cycle

2005

40. Analyze the given assertion and reason, and select the correct option.
Assertion (A): Cohesiveness in Texture Profile Analysis is calculated as the ratio of the area under the second compression peak to the area under the first compression peak.
Reason (R): Cohesiveness measures how well a dairy product withstands a second deformation relative to how it behaved under the first deformation.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2002

41. Which primary TPA parameter is required, along with hardness and cohesiveness, to calculate the secondary parameter "chewiness" in Mozzarella cheese?
(A) Adhesiveness
(B) Springiness
(C) Gumminess
(D) Resilience

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(C) It acts as an emulsifier interacting with proteins and starches
(D) It accelerates the Ostwald ripening process to improve flavor release

2007
77. Which natural dairy stabilizer is derived from red seaweed and exhibits unique synergistic interactions with milk casein?
(A) Sodium alginate
(B) Guar gum
(C) Locust bean gum
(D) Kappa-carrageenan

2018
78. Why is kappa-carrageenan frequently added to chocolate milk at very low concentrations (e.g., 0.02%)?
(A) To induce a thick, solid gel structure similar to pudding
(B) To chemically bleach the cocoa powder for a lighter color
(C) To form a weak thixotropic network that prevents cocoa settling
(D) To increase the sweetness of the beverage without adding extra sugar

2011
79. Which dairy stabilizer is a galactomannan extracted from the seeds of the carob tree and requires heat for full hydration?
(A) Pectin
(B) Locust bean gum (LBG)
(C) Sodium alginate
(D) Guar gum

2005
80. Consider the following statements regarding the formulation of synergistic stabilizer blends in ice cream:
I. Guar gum hydrates rapidly in cold water to provide initial mix viscosity.
II. Locust bean gum provides a smooth texture and excellent heat-shock resistance but requires heating to hydrate.
III. Both guar gum and locust bean gum can promote phase separation (wheying-off) in ice cream mix if used without kappa-carrageenan.
Which of the following is the correct combination of statements?
(A) I and III
(B) II and III
(C) I, II and III
(D) I and II

2021
81. How does high-methoxyl pectin stabilize acidified dairy drinks like drinking yogurt?
(A) It adsorbs onto casein micelles to prevent aggregation
(B) It neutralizes the lactic acid, raising the pH to 7.0
(C) It absorbs all free water, turning the drink into a solid gel
(D) It enzymatically cross-links the fat globules into a uniform matrix

NODIA

2019
82. Which property of sodium alginate makes it particularly useful for forming structured dairy gels (like artificial cheese bits)?
(A) Its extreme solubility and lack of viscosity in cold milk
(B) Its capacity to melt reversibly upon gentle heating
(C) Its ability to form gels in the presence of calcium ions
(D) Its inherent characteristic of rapidly degrading milk proteins

2003
83. Why are emulsifiers and stabilizers often used together (e.g., polysorbate 80 and LBG) in complex dairy matrices?
(A) Emulsifiers manage interfaces, while stabilizers manage viscosity
(B) Because stabilizers alone completely destabilize emulsions within minutes
(C) They chemically react with each other to form a completely new synthetic protein
(D) Emulsifiers provide color, while stabilizers provide sweetness

2018
84. What is the specific role of melting salts (like sodium citrate or sodium phosphate) in the production of processed cheese?
(A) To coagulate the initial milk proteins before cheddaring
(B) To act as traditional emulsifiers by lowering the surface tension of water
(C) To reduce the microbial load in the final packaged product
(D) To sequester calcium and allow proteins to act as emulsifying agents

2006
85. Match the mathematical models with their corresponding flow characteristics.
List I: (Mathematical Models)
P. Newtonian Model

(C) Stokes' equation
(D) Power Law equation

2023

156. What is the fundamental difference between a controlled rate rheometer and a controlled stress rheometer?
(A) Controlled rate instruments strictly measure system temperature, whereas controlled stress variants measure total pressure drop
(B) Controlled rate sets shear rate and measures stress, while controlled stress sets force and measures strain
(C) Controlled rate testing is limited to parallel plate systems, whereas controlled stress uses concentric cylinder systems exclusively
(D) Controlled rate methodology is entirely empirical, whereas controlled stress represents a purely qualitative measurement technique

2009

157. Match the tribological lubrication regimes in List I with their dominant physical characteristics in List II during the oral processing of a dairy product:
List I: (Lubrication Regimes)
P. Boundary lubrication
Q. Mixed lubrication
R. Hydrodynamic lubrication
List II: (Physical Characteristics)
1. Thick fluid film fully supports the load; bulk viscosity dominates
2. Both fluid film and direct surface asperity contacts support the load
3. Direct contact of surfaces dominates; surface properties and thin boundary layers are critical
(A) P-2, Q-1, R-3
(B) P-3, Q-2, R-1
(C) P-1, Q-3, R-2
(D) P-3, Q-1, R-2

2006

158. Which of the following represents an accurate application of tribology in dairy science?
(A) Determining the precise freezing point depression and ice crystal size distribution in ice cream
(B) Calculating the absolute concentration and crystallization rate of lactose in skim milk
(C) Correlating soft-tribology friction coefficients with creaminess or roughness perception
(D) Measuring the directional thermal conductivity and heat capacity profile of butter

2012

159. What happens to the viscosity of a non-Newtonian, shear-thinning dairy fluid as the rotational speed of a coaxial cylinder viscometer is steadily increased?
(A) Viscosity increases proportionally
(B) Viscosity remains constant
(C) Viscosity fluctuates randomly
(D) Viscosity decreases

2022

160. Given below are statements about dairy emulsion destabilization:
I. Creaming is driven by density differences between the fat and aqueous phases.
II. Homogenization prevents creaming by strictly increasing the density of the fat phase.
III. Coalescence is an irreversible thermodynamic process.
IV. Flocculation involves the merging of droplets into a single larger droplet.
Which of the above statements are INCORRECT?
(A) II and IV
(B) I and III
(C) II, III and IV
(D) I and IV

2008

161. Which structural factor makes rennet-coagulated gels more susceptible to syneresis than acid-coagulated gels during cheese making?
(A) Rennet gels completely lack any defined three-dimensional protein network structure
(B) Rennet gels undergo para-casein network contraction, actively expelling whey
(C) Acid gels contain absolutely no trapped water within their porous interstitial spaces
(D) Acid gels are held together by highly stable, unbreakable covalent disulfide bonds

2007

162. How does the addition of polysorbates affect the structure of ice cream during the freezing process?
(A) They strongly bind free water, forming a highly rigid gel that completely stops ice crystal growth
(B) They enzymatically break down the native milk proteins into individual amino acid residues
(C) They rapidly dissolve all existing fat crystals, preventing any solid structure formation

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rate
(D) Kinematic viscosity incorporates the fluid's density

2007

94. Which structural feature primarily prevents the coalescence of milk fat globules in raw, unhomogenized milk?
(A) A thick coating of kappa-carrageenan
(B) The extremely low pH of raw milk
(C) The native Milk Fat Globule Membrane (MFGM)
(D) A rigid network of un-cleaved kappa-casein micelles

2004

95. In evaluating the microstructural network of acid-induced milk gels via SEM, what artifact must researchers be cautious of during sample preparation?
(A) Rapid microbial fermentation during imaging
(B) Network shrinkage caused by dehydration
(C) Melting of lactose crystals due to extreme cold
(D) Spontaneous conversion of the gel back to fluid milk

2023

96. Which rheological behavior is observed when an applied stress is directly proportional to the resulting strain, up to the proportional limit?
(A) Non-Newtonian shear thinning
(B) Bingham plastic flow
(C) Dilatant flow
(D) Hookean elastic behavior

2025

97. What is the fundamental significance of measuring the phase angle ($\tan\delta$) in a cheese sample undergoing ripening?
(A) It tracks elastic-to-viscous transitions
(B) It quantifies the absolute concentration of free fatty acids
(C) It provides the exact moisture content of the cheese block
(D) It determines the color development of the cheese rind

2022

98. Which statement INCORRECTLY pairs a dairy product with its typical rheological classification?
(A) Skim milk – Newtonian
(B) Aged Cheddar cheese – Viscoelastic solid
(C) Sweetened condensed milk – Plastic
(D) Stirred yogurt – Thixotropic, pseudoplastic

2025

99. Which principle explains why high-pressure homogenization increases the viscosity and stability of cream?
(A) It disrupts fat globules to increase surface area
(B) It drastically increases the average size of fat globules
(C) It decreases the number of particles, reducing the volume fraction
(D) It evaporates excess water, concentrating the serum phase

2006

100. Consider the following statements about dairy emulsion stabilizers:
I. They lower interfacial tension significantly better than true emulsifiers.
II. They increase the viscosity of the continuous aqueous phase.
III. They provide kinetic stability against creaming.
IV. They are typically large, complex carbohydrate molecules.
V. They prevent coalescence by providing a rigid mechanical barrier at the interface.
Which of the following is the correct combination of statements regarding the primary function of stabilizers?
(A) II, III and IV
(B) I, II, III and IV
(C) II, IV and V
(D) I, III and V

2012

101. What represents the primary cause of "sandiness" in ice cream over time?
(A) Flocculation of fat globules
(B) Crystallization and growth of lactose
(C) Excessive cross-linking of sodium alginate
(D) Complete separation of the overrun air bubbles

2009

102. Which specific condition leads to the structural failure mode known as "syneresis" in set yogurt?
(A) Boiling the yogurt after fermentation
(B) The complete dissolving of casein micelles into true solution
(C) Contraction of the casein network to squeeze out whey
(D) Rapid expansion of entrapped air bubbles

2010

103. In large deformation testing, how is the "fracture strain" of a block of butter defined?

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Q. Power Law Model
R. Herschel-Bulkley Model
S. Casson Model

List II: (Flow Characteristics)

1. Yield stress followed by shear-thinning or shear-thickening
2. Yield stress commonly applied to chocolate flow
3. Direct proportionality between shear stress and shear rate
4. Curvilinear relationship without a yield stress

(A) P-3, Q-4, R-1, S-2
(B) P-4, Q-3, R-2, S-1
(C) P-3, Q-1, R-4, S-2
(D) P-1, Q-4, R-3, S-2

2018

86. Which phase of dairy foam stability is primarily governed by the drainage of the liquid lamellae between air bubbles?
(A) Initial bubble entrapment
(B) Coarsening
(C) Liquid drainage
(D) Protein adsorption

2009

87. What is the fundamental microstructural difference between a rennet gel and an acid gel?
(A) Acid gels rely exclusively on disulfide bridging, while rennet gels rely on hydrophobic interactions
(B) Rennet gels completely lack a three-dimensional network
(C) Acid gels contain no trapped whey, whereas rennet gels are 100% liquid
(D) Rennet gels have coarse strands, while acid gels form compact clusters

2006

88. When measuring the flow behavior of highly viscous processed cheese at melting temperatures, which rheometer geometry is typically preferred to prevent sample slippage?
(A) Serrated parallel plates
(B) Capillary tube
(C) Concentric cylinder with smooth walls
(D) Falling sphere geometry

2008

89. Which parameter describes the physical resistance of a dairy product to flow out of its packaging, often correlating with yield stress?
(A) Stringiness
(B) Extrudability
(C) Pourability
(D) Cohesiveness

2013

90. Consider the following statements regarding tribological applications in dairy foods:
I. Astringency in low-pH whey drinks is often linked to the depletion of the salivary lubricating film.
II. The hydrodynamic regime of a Stribeck curve is strictly independent of the viscosity of the dairy fluid.
III. Creaminess perception strongly correlates with the boundary and mixed lubrication regimes.
IV. Friction coefficients in dairy tribology are completely unaffected by the fat content.
Which of the following is the INCORRECT combination of statements?
(A) II and IV
(B) I and III
(C) I, II and IV
(D) II, III and IV

2012

91. Which of the following best characterizes the rheological property known as "gumminess" in TPA?
(A) The product of hardness and cohesiveness
(B) The product of hardness and springiness
(C) The ratio of cohesiveness to adhesiveness
(D) The total energy required to masticate a solid food for swallowing

2009

92. Why is structural breakdown in sheared dairy fluids often mathematically modeled using a kinetic decay equation?
(A) Because viscosity drops instantly to zero under any applied shear
(B) Because temperature increases logarithmically during shearing
(C) Because structural rupture follows reaction kinetics
(D) Because fat globules undergo rapid radioactive decay

2010

93. What distinguishes kinematic viscosity from dynamic viscosity in the analysis of dairy liquids?
(A) Dynamic viscosity only applies to solid cheeses
(B) Kinematic viscosity is solely measured using a TPA machine
(C) Dynamic viscosity is independent of shear

NODIA

(A) A Bingham plastic exhibits linear flow behavior once its yield stress is exceeded, whereas a pseudoplastic fluid exhibits shear-thinning without a yield stress
(B) A pseudoplastic fluid requires a yield stress, whereas a Bingham plastic does not
(C) A Bingham plastic is entirely gaseous, whereas a pseudoplastic is liquid
(D) A Bingham plastic's viscosity increases over time, whereas a pseudoplastic's decreases

2017

114. Which instrumental parameter is used to quantify "springiness" in Texture Profile Analysis of cheese?
(A) The force required to pull the probe from the sample
(B) The ratio of the area of the second compression to the first compression
(C) The distance the sample recovers its height between compression cycles
(D) The area under the first compression curve multiplied by cohesiveness

2023

115. What physical phenomenon primarily dictates the transition from boundary to mixed lubrication in the oral processing of a dairy beverage?
(A) Entrainment of a thin fluid film
(B) The complete evaporation of the continuous phase
(C) The crystallization of lactose on the tongue
(D) The sudden phase inversion of the emulsion

2017

116. Which type of emulsifier exhibits the highest hydrophilic-lipophilic balance (HLB) value?
(A) Mono- and diglycerides of fatty acids
(B) Sorbitan monostearate (Span 60)
(C) Polysorbate 80 (Tween 80)
(D) Sorbitan tristearate (Span 65)

2014

117. What is the defining characteristic of an emulsion experiencing Ostwald ripening?
(A) Smaller droplets dissolve and redeposit onto larger droplets
(B) Droplets repel each other strongly due to high zeta potential
(C) Dispersed droplets spontaneously solidify into a crystalline phase
(D) Dispersed phase molecules rapidly evaporate into the headspace

2019

118. Which statement regarding the measurement of yield stress in dairy suspensions is correct?
(A) It requires a capillary viscometer to obtain precise and highly reproducible results
(B) It is a fundamental physical property that remains unaffected by temperature variations
(C) It is typically observed only in highly dilute, true thermodynamic solutions
(D) It depends on the applied mathematical model and the measurement timeframe

2017

119. In the context of dairy gelation, what role does temperature play in rennet coagulation?
(A) Rennet enzymes exhibit their maximum catalytic activity near freezing temperatures
(B) Coagulation accelerates up to 40–45°C, above which chymosin begins to denature
(C) Temperature changes have no significant or measurable effect on chymosin kinetics
(D) Extremely high temperatures exceeding 90°C instantly accelerate enzyme action

2024

120. Match the microstructural analysis techniques in List I with their primary application characteristic in List II:

List I: (Microstructural Analysis Techniques)
P. Confocal Laser Scanning Microscopy
Q. Transmission Electron Microscopy
R. Scanning Electron Microscopy
S. Light Microscopy

List II: (Application Characteristics)
1. Surface topography and 3D appearance of a dried sample
2. Optical sectioning of hydrated, fluorescently stained samples
3. Ultra-high resolution of internal structures of thin sample sections
4. Basic structural observation requiring minimal preparation, low resolution

(A) P-2, Q-3, R-1, S-4
(B) P-1, Q-4, R-2, S-3
(C) P-3, Q-2, R-4, S-1
(D) P-2, Q-1, R-3, S-4

2001

121. What happens to the storage modulus (G') of a milk sample as it transitions from a liquid to an acid-induced gel?
(A) It drops rapidly below zero
(B) It remains identical to the loss modulus (G') throughout the process

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2011

139. Which intrinsic factor most heavily dictates the texture of processed cheese?

(A) The specific quantity of dissolved oxygen gas in the formulation mix

(B) The ratio of intact to hydrolyzed casein

(C) The natural yellow coloration of the native milk fat globules

(D) The external atmospheric pressure maintained during the packaging phase

2013

140. Given below are the steps involved in determining the flow behavior index (n) and consistency index (K) using a rotational viscometer:

I. Fit the data to the Power Law equation ($\ln(\sigma) = \ln(K) + n\ln(\dot{\gamma})$)

II. Measure the corresponding shear stress (σ) at each speed

III. Apply a range of varying rotational speeds (shear rates, $\dot{\gamma}$)

IV. Extract K from the intercept and n from the slope of the log-log plot

Which of the following represents the correct sequence of these steps?

(A) III, II, I, IV

(B) I, II, III, IV

(C) II, III, IV, I

(D) III, I, II, IV

2014

141. What is the chief advantage of using Texture Profile Analysis (TPA) for evaluating dairy products?

(A) It mimics human chewing via two compression cycles

(B) It calculates fundamental SI physical units for dynamic viscosity

(C) It provides a chemical analysis of the total fat content in the sample

(D) It measures the thickness of the tribological boundary lubrication layer

2002

142. Which mechanism explains how sodium alginate forms strong gels in dairy systems?

(A) The generation of strong covalent disulfide linkages with native whey proteins

(B) Direct precipitation induced by severe acidification of the system to pH 4.6

(C) Egg-box cross-linking of guluronic acid blocks by calcium ions

(D) Weak hydrophobic interactions occurring between non-polar amino acid side chains

2004

143. Why is it difficult to measure the fundamental rheological properties of highly aerated dairy foams using standard rotational rheometry?

(A) Dairy foams possess absolutely zero apparent shear viscosity under standard measuring conditions

(B) Foams are restricted to exhibiting purely linear Newtonian behavior

(C) The dispersed gas bubbles directly interfere with the magnetic fields

(D) Rotation destroys bubble structure, and wall slip confounds results

2015

144. Which process relies on the principle of Ostwald ripening to intentionally alter the texture of a dairy product?

(A) The thermal aging of standard ice cream mix to promote the controlled crystallization of liquid fat

(B) The rapid freezing of ice cream formulation inside a specialized scraped surface heat exchanger

(C) The growth of large calcium lactate crystals at the expense of small ones in aged cheese

(D) The high-temperature pasteurization of raw whole milk to eliminate pathogenic microflora

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2007

145. What is the fundamental role of Bancroft's rule in emulsion formulation?

(A) It determines the exact percentage of overrun achieved during mechanical foaming

(B) The phase where the emulsifier is most soluble becomes the continuous phase

(C) It calculates the maximum packing fraction parameter of non-spherical fat particles

(D) It dictates the precise thermal degradation rate constant of whey proteins

2016

146. Which of the following best describes the "springiness" parameter in TPA?

(A) The maximum compressive force required to completely crush the solid sample

(B) The total mechanical work required to withdraw the probe from the test sample

(C) The sample's total physical resistance to enzymatic breakdown and proteolysis

(D) The extent to which a deformed sample recovers its original height before the second compression

2022

130. Given below are three lubrication regimes encountered in the oral cavity as the sliding speed of the tongue increases during the consumption of a dairy drink:

I. Hydrodynamic lubrication
II. Boundary lubrication
III. Mixed lubrication

Which of the following represents the correct sequence of these regimes?

(A) II, III, I
(B) I, III, II
(C) III, II, I
(D) I, II, III

2008

131. Which of the following stabilizers functions by forming a thermo-reversible gel upon cooling?

(A) Kappa-carrageenan
(B) Native starch
(C) Microcrystalline cellulose
(D) Xanthan gum

2004

132. What is the primary purpose of conducting a "strain sweep" in dynamic oscillatory rheometry of a dairy gel?

(A) To estimate the long-term shelf life of the gel under fixed temperature conditions
(B) To calculate the kinematic viscosity of the serum phase under high shear
(C) To identify the linear viscoelastic region (LVR) of the gel
(D) To rapidly break down the sample structure to determine its precise fracture stress

2025

133. Which term refers to the ability of a foam to resist spontaneous breakdown over time due to gas diffusion and liquid drainage?

(A) Foam stability
(B) Overrun
(C) Syneresis
(D) Phase inversion

2005

134. What effect does increasing the volume fraction (ϕ) of dispersed fat droplets have on the apparent viscosity of cream?

(A) Apparent viscosity decreases in a strictly linear fashion as volume fraction rises
(B) Apparent viscosity remains completely constant regardless of concentration shifts
(C) Apparent viscosity fluctuates in a highly unpredictable sinusoidal wave pattern
(D) Apparent viscosity rises exponentially near maximum packing

2008

135. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).

Assertion (A): The Einstein equation is inadequate for predicting the viscosity of heavy cream (40% fat).

Reason (R): The Einstein equation assumes no hydrodynamic interactions between dispersed particles, which is only valid for highly dilute suspensions (volume fraction < 0.05).

Which of the following is correct?

(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2019

136. Which microstructural change is most directly responsible for the phenomenon of "cream plug" formation in bottled unhomogenized milk?

(A) High activity of enzymes leading to the rapid breakdown of lactose
(B) The continuous precipitation of whey proteins at the bottom of the container
(C) Fat globule coalescence at the surface into a solid layer
(D) The extremely rapid proliferation of mold colonies on the milk surface

2001

137. Which of the following correctly pairs a rheological behavior with its physical description?

(A) Rheopexy – Time-dependent decrease in viscosity
(B) Thixotropy – Time-dependent increase in viscosity
(C) Pseudoplasticity – Shear stress is independent of shear rate
(D) Dilatancy – Shear-thickening behavior

2023

138. In the evaluation of large deformation mechanics, what does the area under the stress-strain curve up to the point of fracture signify?

(A) The toughness of the cheese
(B) The purely elastic modulus of the material
(C) The precise thermal melting point of the cheese
(D) The dynamic kinematic viscosity of the serum whey

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(C) It fluctuates in a sinusoidal pattern indefinitely
(D) It increases exponentially, eventually surpassing the loss modulus (G')

2005
122. Which factor primarily limits the overrun achievable in standard dairy whipping cream?
(A) The degree of partial fat coalescence required to stabilize air bubbles
(B) The absolute concentration of lactose dissolved in the serum phase
(C) The overall percentage of soluble whey proteins removed during centrifugal separation
(D) The specific concentration of divalent minerals in the aqueous phase

2021
123. How does the presence of high-molecular-weight polysaccharides (like guar gum) affect the sensory perception of astringency in dairy beverages?
(A) It increases astringency through direct cross-linking with salivary proteins
(B) It lowers astringency by increasing viscosity and lubricating oral surfaces
(C) It induces rapid casein precipitation, leading to a highly chalky texture
(D) It completely removes the physiological need for normal salivary lubrication

2022
124. Which condition favors the occurrence of coalescence over flocculation in an oil-in-water dairy emulsion?
(A) The presence of a highly thick and elastic viscoelastic interfacial protein film
(B) A thin, weak interfacial film that easily ruptures during collisions
(C) The establishment of high electrostatic repulsive forces between droplets
(D) A high overall concentration of steric stabilizers surrounding the droplets

2015
125. Which rheological behavior is typically exhibited by highly concentrated whey protein isolate solutions subjected to very high shear rates?
(A) Shear-thickening behavior
(B) Ideal Newtonian flow behavior
(C) Shear-thinning pseudoplasticity
(D) Viscoelastic plastic flow behavior

2016
126. What is the fundamental principle behind using an orifice viscometer (e.g., Ford cup) for dairy testing?
(A) Measuring the total mechanical torque required to rotate a spindle at a designated speed
(B) Measuring the precise pressure drop across a highly pressurized horizontal pipe
(C) Measuring gravity-driven efflux time of a set volume through a bottom orifice
(D) Measuring the absolute attenuation of high-frequency acoustic waves in the fluid

2009
127. Why are orifice viscometers considered empirical rather than fundamental rheological tools?
(A) They require highly advanced computational fluid dynamics software for basic operations
(B) They are restricted to measuring the dynamic loss modulus under high-frequency conditions
(C) They are functionally limited and can only operate efficiently in a vacuum environment
(D) The changing head causes shear rate variation, preventing absolute calculations

2025
128. In tribology, what does the Stribeck curve plot to characterize lubrication behavior?
(A) Yield stress of the material versus the applied shear rate
(B) Apparent dynamic viscosity of the liquid versus the ambient system temperature
(C) Friction coefficient versus a multi-variable entrainment parameter
(D) Complex modulus of the gel versus the oscillatory frequency

2025
129. Which of the following best explains why low-fat cheeses often have a firmer and more rubbery texture than full-fat cheeses?
(A) Fat globules behave as active structural elements that heavily cross-link the casein network
(B) Fat acts as a filler disrupting the casein network; its removal yields a denser protein matrix
(C) Low-fat cheeses physically entrap significantly higher volumes of micro-sized air bubbles
(D) The moisture-to-protein ratio is typically doubled during the manufacturing of low-fat cheeses

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2003

147. Under which condition does the apparent viscosity of a pseudoplastic dairy fluid approach its high-shear limiting viscosity (η_∞)?
(A) At very high shear rates where alignment is maximized
(B) At extremely low shear rates approaching zero shear conditions
(C) Strictly when system temperatures fall below the freezing point
(D) When the volume fraction of the dispersed phase is exactly zero

2018

148. Which microstructural evaluation technique is most appropriate for observing the distribution of individual fat crystals within an ice cream matrix without melting them?
(A) Standard Light Microscopy performed at elevated room temperature
(B) Capillary Viscometry
(C) Cryo-Scanning Electron Microscopy (Cryo-SEM)
(D) Atomic Force Microscopy in liquid mode

2025

149. What is a specific disadvantage of the Herschel-Bulkley model when characterizing dairy suspensions?
(A) It requires three parameters, making curve fitting more complex than two-parameter models
(B) It completely lacks any yield stress term, which prevents its application to highly structured fluids
(C) It assumes that the test fluid is perfectly Newtonian across all shear ranges
(D) It is only applicable to ideal gases and cannot be used for dairy liquids

2007

150. Given below are statements about the rheology of butter:
I. Butter exhibits a distinct yield stress.
II. Butter is a water-in-oil (W/O) emulsion.
III. The continuous phase of butter is entirely liquid fat at refrigeration temperatures.
Which of the above statement(s) is/are correct?
(A) I and II
(B) II and III
(C) I and III
(D) I

2011

151. Which factor contributes most to the "chewiness" of a Mozzarella cheese on a pizza?
(A) High initial moisture content combined with extremely low pH values
(B) The oriented, fibrous network of cross-linked casein
(C) The complete and total absence of any emulsified milk fat globules
(D) The presence of a highly rigid, thermo-reversible kappa-carrageenan gel

2001

152. How does the concept of "time-dependent structural breakdown" in yogurt relate to consumer perception?
(A) It causes the overall yogurt formulation to taste significantly sweeter during storage
(B) It prevents the yogurt gel structure from ever being swallowed comfortably by the consumer
(C) Stirred yogurt thins and becomes more liquid-like during mixing or chewing
(D) It explains why yogurt gels become progressively harder the longer they remain in the oral cavity

2013

153. What role does the "Laplace pressure" play in foam destabilization?
(A) It actively stabilizes the foam matrix by solidifying the individual air bubbles
(B) It chemically alters the flavor volatile profile of the aerated dairy foam
(C) It prevents gravity-induced liquid drainage through the thin film lamellae
(D) It drives gas diffusion from small to large bubbles due to pressure differences

2024

154. Which synergistic effect is achieved by blending locust bean gum (LBG) and xanthan gum in a dairy formulation?
(A) Formation of a strong gel structure not formed by either alone
(B) The rapid and uncontrolled phase separation of the functional milk proteins
(C) The complete and total sensory masking of all desirable native dairy flavors
(D) The immediate chemical precipitation of soluble ionic milk calcium species

2006

155. Which of the following equations is primarily used to model the temperature dependence of viscosity in liquid dairy products?
(A) Einstein equation
(B) Arrhenius equation

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(A) The exact force at which the butter melts
(B) The speed at which the compression probe descends
(C) The relaxation time after stress removal
(D) The deformation at structural failure

2021

104. Which mechanism is primarily responsible for the destabilization of milk proteins when alcohol is added (as in the alcohol test)?
(A) Dehydration of casein micelles
(B) Enzymatic hydrolysis of casein
(C) Irreversible unfolding of alpha-lactalbumin
(D) Spontaneous increase in the pH of the milk

2005

105. Analyze the given assertion and reason, and select the correct option.
Assertion (A): The apparent viscosity of a pseudoplastic dairy fluid decreases as the shear rate increases.
Reason (R): High shear rates cause randomly oriented polymer molecules or suspended particles to align with the direction of flow, reducing internal frictional resistance.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2010

106. In dairy formulations, why is a blend of mono- and diglycerides often preferred over a pure monoglyceride emulsifier?
(A) The blend completely prevents fat crystallization
(B) The blend offers better functional balances for fat agglomeration
(C) Pure monoglycerides are highly toxic
(D) Pure monoglycerides strictly form W/O emulsions regardless of the formulation

2006

107. Which tribological parameter correlates most strongly with the perception of "smoothness" in a dairy dessert?
(A) Low coefficient of friction
(B) High coefficient of friction in the boundary regime
(C) Extremely high yield stress
(D) Rapid syneresis upon oral compression

2014

108. What is the fundamental limitation of using a simple rotational viscometer with a standard spindle (like Brookfield) for fundamental rheological analysis of non-Newtonian dairy fluids?
(A) The temperature cannot be controlled
(B) It only measures dynamic storage modulus
(C) Non-uniform shear rate across the gap
(D) It destroys the sample completely during insertion

2009

109. Which dairy process heavily relies on the application of high shear stress to induce intentional phase inversion (O/W to W/O)?
(A) Pasteurization of skim milk
(B) Fermentation of milk into yogurt
(C) Spray drying of whey powder
(D) Churning of cream into butter

2025

110. Under controlled stress rheometry, a "creep-recovery" test is performed on cheese. What does the non-recoverable portion of the strain represent?
(A) The purely elastic behavior of the cheese
(B) The exact fracture stress of the cheese
(C) Permanent viscous deformation
(D) The dynamic loss modulus

2015

111. Which mathematical model explicitly accounts for structural breakdown over time at a constant shear rate in a thixotropic dairy fluid?
(A) Einstein equation
(B) Tiu-Boger model
(C) Casson equation
(D) Power law equation

2013

112. Why does the addition of sucrose to dairy desserts significantly alter their rheological profile?
(A) Sucrose acts as a potent surfactant, instantly creating W/O emulsions
(B) Sucrose chemically cross-links with casein to form a rigid covalent gel
(C) Sucrose actively denatures whey proteins at room temperature
(D) Sucrose binds free water, increasing the biopolymer volume fraction

2013

113. In the classification of dairy fluids, how does a Bingham plastic differ from a pseudoplastic fluid?

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(D) They displace proteins from fat globules, promoting partial coalescence to trap air

2023

163. What is the main structural characteristic of a "Bingham plastic" fluid, such as tomato paste or certain dairy purees?
(A) It flows only after exceeding a yield stress, then behaves as a Newtonian fluid
(B) It exhibits strong shear-thickening dilatant behavior without possessing any yield stress
(C) It completely lacks any physical resistance to applied mechanical deformation forces
(D) It recovers its original structure instantaneously upon the complete removal of shear

2014

164. In dynamic testing, what does a phase angle (δ) of 90 degrees strictly indicate about a dairy material?
(A) It is a perfect Hookean solid
(B) It is a complex viscoelastic material
(C) It is a purely viscous Newtonian liquid
(D) It has fractured completely

2008

165. Why is the "controlled stress" geometry generally preferred for measuring the yield stress of a delicate dairy gel like yogurt?
(A) It applies small stress increments to identify the onset of flow
(B) It applies extremely high, destructive shear rates almost instantaneously to the gel
(C) It completely prevents the delicate yogurt from physically contacting the rheometer walls
(D) It is restricted to measuring only the dynamic elastic storage modulus under shear

2006

166. Which physical property is the primary driver for creaming in raw milk according to Stokes' law?
(A) The extremely high yield stress exhibited by raw whole milk under static conditions
(B) The rapid biological growth and proliferation of active lactic acid bacteria species
(C) The high concentration of dissolved oxygen gas within the milk plasma phase
(D) The density difference between fat globules and continuous skim milk

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2011

167. Which of the following represents an accurate inference regarding the use of cone-and-plate rheometry for measuring the viscosity of milk?
(A) It is highly unsuitable because milk completely lacks any measurable yield stress
(B) It is ideal because the shear rate is uniform in the gap
(C) It is preferred because it easily handles massive, highly heterogeneous chunks of cheese
(D) It is ineffective because native milk is too highly viscous for the narrow sample gap

2006

168. Which parameter is a secondary calculation in TPA, derived by multiplying hardness, cohesiveness, and springiness?
(A) Fracturability
(B) Gumminess
(C) Chewiness
(D) Resilience

2024

169. What is a key limitation of the Texture Profile Analysis (TPA) methodology?
(A) It is strictly restricted to measuring low-viscosity liquid dairy products and emulsions
(B) It exclusively provides fundamental rheological SI units that are difficult for humans to comprehend
(C) It requires the solid test sample to be completely vaporized prior to mechanical compression
(D) It is an empirical test highly dependent on probe geometry, sample size, and test speed

2005

170. Given below are statements regarding specific viscometers:
I. Capillary viscometers rely heavily on pressure differences and pipe dimensions.
II. Falling sphere viscometers are highly suitable for non-Newtonian fluids.
III. Orifice viscometers are widely used in quality control for rapid, empirical testing.
IV. Rotational viscometers can measure time-dependent rheological changes.
V. Falling sphere viscometers strictly require transparent or translucent samples.
Which of the above statements are correct?
(A) I, III, IV and V
(B) I, II, III and V
(C) II, III, IV and V
(D) I, II, III and IV

2022

171. How does high-pressure processing (HPP) alter the rheological properties of milk compared to standard thermal pasteurization?

(A) HPP causes severe non-enzymatic browning and Maillard reactions that heavily increase the overall system viscosity

(B) HPP disrupts casein micelles and denatures whey proteins, slightly raising viscosity without thermal damage

(C) HPP entirely eliminates the continuous aqueous phase by forcing all water into the hydrophobic fat core

(D) HPP instantly transforms low-fat skim milk into a highly rigid, solid-like Bingham plastic material

2002

172. Which interaction primarily governs the synergistic gelation of kappa-carrageenan and casein micelles in milk?

(A) Direct covalent bonding occurring between polysaccharide sulfate groups and free lactose molecules

(B) Electrostatic binding between carrageenan sulfates and positive kappa-casein regions

(C) Strong hydrophobic interactions occurring between the hydrophilic carrageenan and non-polar milk fat

(D) Complete complex coacervation of all milk components occurring at highly alkaline system pH values

2022

173. What is the fundamental difference between "apparent viscosity" and "complex viscosity"?

(A) Apparent is from steady shear, while complex is from oscillatory testing

(B) Apparent viscosity only applies to crystalline solids, whereas complex viscosity only applies to Newtonian liquids

(C) Apparent viscosity heavily accounts for temperature, whereas complex viscosity is completely independent of temperature

(D) Apparent viscosity is a fundamental material constant, whereas complex viscosity changes constantly under static conditions

2006

174. Which process most effectively prevents the Ostwald ripening of a dairy emulsion?

(A) Introducing highly soluble smaller fat droplets into the system to stabilize the local interfacial tension

(B) Rapidly heating the dairy emulsion to boiling to permanently denature all surfactant proteins

(C) Adding a highly insoluble oil to the dispersed phase to eliminate the concentration gradient

(D) Vigorously and continuously agitating the bulk emulsion to prevent any thermodynamic local gradient

2002

175. Why is a highly concentrated sodium caseinate solution considered a steric stabilizer rather than a simple surfactant?

(A) It completely and permanently neutralizes all positive electrical charges on the droplet surface

(B) It chemically digests the core fat droplet into individual free fatty acids and glycerol molecules

(C) It acts primarily as a low-molecular-weight lipophilic surfactant compound in aqueous solutions

(D) It forms a thick, hydrated polymer layer around the droplet that prevents coalescence

2019

176. Which of the following represents an accurate classification of mayonnaise?

(A) It is a classic thermodynamic water-in-oil (W/O) emulsion stabilized by high levels of solid fat

(B) It is a highly dilute, optically clear true aqueous solution of proteins and low-weight sugars

(C) A concentrated oil-in-water emulsion showing pseudoplastic behavior due to crowding

(D) It is a highly complex, thermodynamically unstable multiple emulsion of the water-in-oil-in-water (W/O/W) type

2007

177. Which mathematical model would be least appropriate for describing the flow behavior of a purely Newtonian fluid like water?

(A) Stokes' law equation

(B) Casson equation

(C) Poiseuille's law

(D) Simple Newtonian model
(Shear Stress = Viscosity × Shear Rate)

2006

178. What determines the "yield stress" of a dairy gel on a microscopic level?

(A) The precise rotational velocity and design geometry of the chosen rheometer spindle

(B) The specific coloration, light scattering, and

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opacity of the internal dispersed phase
(C) The exact thermodynamic boiling temperature and vapor pressure of the continuous phase
(D) The number and strength of bonds forming the continuous three-dimensional network

2023
179. In dairy tribology, why does the friction coefficient often rise again in the hydrodynamic lubrication regime at very high sliding speeds?
(A) Due to viscous drag and internal friction of the fluid film opposing motion
(B) Due to the complete physical depletion of the protective molecular boundary layer
(C) Due to rapid, shear-induced crystallization and solidification of the carrier fluid
(D) Due to the direct, destructive physical scraping of opposing surface asperities

2007
180. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): Emulsifiers with low HLB values (e.g., HLB 3-6) are used to promote water-in-oil (W/O) emulsions, such as butter or margarine.
Reason (R): Low HLB emulsifiers are predominantly lipophilic, making them more soluble in the oil phase, which according to Bancroft's rule, favors the oil becoming the continuous phase.
Which of the following is correct?
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2023
181. Which instrument is most commonly used to measure the fundamental viscoelastic properties (G', G'') of dairy gels?
(A) Dynamic Shear Rheometer
(B) Texture Analyzer (TPA)
(C) Bostwick Consistometer
(D) Falling Sphere Viscometer

2022
182. How does the concept of "partial coalescence" differ from complete coalescence in ice cream production?
(A) Partial coalescence strictly involves the stabilization of air bubbles, whereas complete coalescence is restricted to fat
(B) Partial coalescence is a thermodynamic process that exclusively occurs at elevated temperatures exceeding 50°C
(C) Partial coalescence represents a fully physical reversible process, whereas complete coalescence is highly irreversible
(D) Partial coalescence forms irregular fat clumps; complete coalescence merges droplets fully

NODIA

2023
183. Which statement accurately describes the effect of increasing the dispersed phase volume fraction on emulsion rheology?
(A) It decreases the apparent shear viscosity of the cream in an exponential fashion as concentration increases
(B) It shifts flow from Newtonian to shear-thinning, eventually inducing a yield stress
(C) It causes the oil-in-water emulsion to immediately and spontaneously invert to a water-in-oil system
(D) It completely and permanently eliminates all measurable viscoelastic storage and loss properties

2005
184. What happens when the shear rate applied to a thixotropic yogurt sample is suddenly stepped down to a lower, constant value?
(A) Apparent viscosity continues to decrease exponentially under the newly applied lower shear rate
(B) Apparent viscosity drops instantly to zero due to sudden structural collapse within the gel
(C) Viscosity gradually increases over time as structure rebuilds
(D) Apparent viscosity remains permanently locked at the absolute lowest value achieved during shear

2023
185. Which component of milk is primarily responsible for its inherent surface-active properties (acting as natural emulsifiers/foaming agents)?
(A) Lactose
(B) Dissolved ionic minerals like calcium and phosphorus
(C) Water
(D) Milk proteins (Caseins and Whey proteins)

2005

216. In the context of large deformation mechanics, what does an intensely brittle failure of cheese indicate about its structure?
(A) It possesses a very high fracture strain parameter and can deform heavily prior to macroscopic breaking
(B) It behaves entirely and strictly as a classic Bingham plastic fluid under standard compression cycles
(C) It has a low fracture strain, snapping with little structural yielding
(D) It completely and demonstrably lacks any solid, continuous three-dimensional casein protein matrix

2014

217. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): Concentrated sweetened condensed milk typically exhibits non-Newtonian, shear-thinning behavior.
Reason (R): The high concentration of sugar and suspended milk solids creates intermolecular entanglements that align and offer less resistance under increasing shear rates.
Which of the following is correct?
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2013

218. Which statement correctly identifies a limitation of using the Texture Profile Analysis (TPA) parameter "adhesiveness"?
(A) The negative force area is highly dependent on probe speed and surface material
(B) It is limited because it strictly and only measures the absolute temperature profile of the test sample
(C) It can only be calculated if the solid food sample completely and catastrophically shatters under load
(D) It is only applicable and mathematically valid when testing purely linear viscous Newtonian liquids

2021

219. What rheological phenomenon is primarily responsible for the "spoonability" of set yogurt?
(A) Its exhibit of perfect, linear, time-independent true Newtonian flow behavior
(B) Its high yield stress, allowing it to hold shape on the spoon
(C) Its extreme shear-thickening dilatant flow behavior occurring under simple gravity forces
(D) Its absolute and complete lack of any measurable viscoelastic dynamic storage modulus

2022

220. Which term specifically describes an emulsion system such as water-in-oil-in-water (W/O/W)?
(A) Simple single emulsion
(B) Multiple emulsion
(C) Microemulsion
(D) Nanoemulsion

2018

221. Why is the "Casson equation" uniquely preferred for modeling the flow of molten chocolate in the dairy-confectionery industry?
(A) It fits both yield stress and shear-thinning of molten chocolate better than the Bingham model
(B) It completely lacks any yield stress term, allowing highly accurate modeling of high-fluidity chocolate
(C) It exclusively and highly accurately measures the temperature-dependent crystallization rate of cocoa butter
(D) It is built on the fundamental assumption that molten chocolate behaves as a perfect elastic solid material

2015

222. What causes the phase angle (δ) of a highly structured dairy gel to be close to 0 degrees?
(A) The viscous loss modulus (G'') vastly and significantly exceeds the elastic storage modulus (G')
(B) The structured dairy gel is currently undergoing extremely rapid, irreversible syneresis processes
(C) The elastic storage modulus (G') vastly exceeds the loss modulus (G'')
(D) The dairy fluid exhibits perfectly linear Newtonian behavior across all applied shear rates

2001

223. Which microstructural change defines the transition from a "sol" to a "gel" during the acidification of milk?
(A) The complete and irreversible biochemical

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2025

194. In the context of dairy emulsions, what does the Bancroft rule imply about formulating a dairy-based coffee creamer (O/W emulsion)?

(A) The chosen surfactant emulsifier must exhibit high solubility in the lipid oil phase

(B) The formulated cream emulsion must be completely frozen prior to adding to hot coffee

(C) The chosen emulsifier must possess zero molecular interactions with water molecules

(D) The emulsifier must be highly water-soluble

2017

195. Which type of deformation is strictly occurring when measuring the dynamic modulus (G') in the linear viscoelastic region (LVR)?

(A) Small, recoverable elastic deformation

(B) Large, completely irreversible plastic deformation under high strain

(C) Complete, catastrophic macrostructural fracture of the gel network

(D) Rapid, highly chaotic turbulent fluid flow throughout the sample

2002

196. What causes the "shear-thickening" (dilatant) behavior occasionally observed in highly concentrated whey protein dispersions?

(A) The complete alignment and streamlining of protein molecules in the direction of bulk flow

(B) The spontaneous thermodynamic melting and structural dissolution of the whey proteins

(C) Shear-induced jamming of particles, increasing flow resistance

(D) The highly rapid mechanical absorption of ambient air molecules from the environment

2025

197. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).

Assertion (A): The apparent viscosity of milk increases slightly following high-pressure homogenization.

Reason (R): Homogenization creates a vast number of smaller fat droplets, which instantly fuse into a solid, rigid fat matrix.

Which of the following is correct?

(A) Both A and R are true and R is the correct explanation of A.

(B) Both A and R are true but R is not the correct explanation of A.

(C) A is true but R is false.

(D) A is false but R is true.

2009

198. Which structural phenomenon differentiates a "weak gel" (like stirred yogurt) from a "strong gel" (like set Cheddar cheese) under dynamic rheological testing?

(A) A weak gel is characterized by a loss modulus (G') that is significantly greater than its storage modulus (G')

(B) A weak gel is defined by having absolutely no detectable yield stress under any measuring conditions

(C) A strong gel behaves exactly like a purely viscous Newtonian fluid even when subjected to high shear rates

(D) A weak gel has a G' dependent on frequency and breaks at lower strain

2014

199. What does the term "overrun" in the production of whipped cream practically dictate regarding its physical properties?

(A) Overrun represents a value that strictly measures the total chemical fat content of whipped cream

(B) It measures the volume of air incorporated, where higher overrun corresponds to a fluffier, less dense foam structure

(C) A higher overrun increases the apparent liquid density of the bulk cream phase in an exponential manner

(D) The presence of overrun entirely and permanently prevents the occurrence of the Gibbs-Marangoni effect

2001

200. Which type of rheometer geometry is highly susceptible to "edge failure" or sample spillage when testing highly elastic dairy gels at high rotational speeds?

(A) Capillary tube

(B) Falling sphere

(C) Cone-and-plate

(D) Concentric cylinders

NODIA

2018

201. Which specific property of milk fat contributes most to the spreadability of butter at refrigeration temperatures?

(A) The absolute size distribution of the dispersed water droplets

(B) The precise amount of dissolved lactose present in the continuous aqueous phase

(B) To chemically bleach the entire dairy formulation for a highly white and visually appealing color
(C) To ensure that the formulated dessert completely and rapidly liquefies at standard refrigeration temperatures
(D) To leverage synergistic gum gelation for texture and the emulsifier for smooth meltdown

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2007

209. What is the precise physical meaning of the "consistency index" (K) in the Power Law model?

(A) It represents the exact yield stress value required to initiate flow in the fluid

(B) A measure of fluid viscosity at a shear rate of 1 s^{-1}

(C) It directly indicates the kinetic rate of thixotropic structural breakdown over shear

(D) It mathematically determines the precise transition point from laminar to turbulent flow

2010

210. Which primary structural factor drives the "Ostwald ripening" destabilization in dairy foams?

(A) The extremely high overall concentration of kappa-carrageenan polymers in the continuous phase

(B) The highly rapid freezing and solidification kinetics of the continuous serum phase of the foam

(C) The enzymatic cleavage and subsequent degradation of the protective fat globule membrane layer

(D) Laplace pressure differences between different-sized bubbles

2005

211. How does homogenization strictly prevent the creaming of milk fat?

(A) By reducing fat globule diameter, slowing creaming per Stokes' Law

(B) By chemically altering the native density of the milk fat phase to match water exactly

(C) By increasing the apparent shear viscosity of the continuous phase until it acts as a solid

(D) By completely destroying and denaturing all the native, surface-active milk proteins

2007

212. Match the TPA textural properties in List I with their corresponding calculation method in List II:

List I: (Textural Properties)

P. Gumminess

Q. Chewiness

R. Resilience

S. Hardness

List II: (Calculation Methods)

1. Peak force of the first compression
2. Hardness × Cohesiveness
3. Gumminess × Springiness
4. Ratio of recoverable area to total area during the first compression

(A) P-2, Q-3, R-4, S-1

(B) P-1, Q-2, R-3, S-4

(C) P-3, Q-4, R-1, S-2

(D) P-2, Q-4, R-3, S-1

2017

213. Which concept explains why a dairy foam stabilized solely by low-molecular-weight surfactants is typically less stable than one stabilized by milk proteins?

(A) Proteins form a cohesive, viscoelastic interfacial film that resists disruption

(B) Low-molecular-weight surfactants form a highly rigid, brittle interfacial layer upon adsorption

(C) Surfactants rapidly and significantly increase the overall bulk density of the liquid serum phase

(D) Milk proteins spontaneously and continuously generate internal gas pockets under static conditions

2018

214. What occurs during the "coarsening" phase of a dairy emulsion?

(A) The formulated cream emulsion rapidly reverts back to its native raw whole milk state

(B) The continuous phase completely and instantly evaporates under standard atmospheric pressure

(C) The dairy product quickly develops a significantly darker color due to active Maillard browning

(D) Average droplet size increases via coalescence and Ostwald ripening

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2013

215. Which specific interaction provides the highly structured, synergistic gel formed by locust bean gum and kappa-carrageenan?

(A) High electrostatic repulsive forces occurring between the two structurally identical anionic polymers

(B) Binding between smooth galactomannan regions and carrageenan double helices

(C) Complete thermodynamic phase separation of the biopolymers into two entirely distinct gel networks

(D) Direct covalent cross-linking of polysaccharide chains initiated by high-temperature degradation

2010

186. Which parameter is a critical indicator of the physical stability of an oil-in-water dairy emulsion against creaming over a long shelf life?
(A) Small droplet size and high continuous phase viscosity
(B) The precise overall number of carbon atoms present in the lipid molecules
(C) A highly reduced continuous phase viscosity combined with extremely large droplets
(D) The specific chemical presence of low-HLB surfactant emulsifiers in the oil

2010

187. What does the "loss tangent" ($\tan\delta$) precisely equal in dynamic rheological testing?
(A) The mathematical product of G' and G' moduli
(B) The ratio of G' to G'
(C) The calculated square root of complex dynamic viscosity
(D) The direct inverse value of apparent shear viscosity

2009

188. Which microstructural feature provides the high mechanical strength of a Cheddar cheese curd?
(A) Complete structural separation of the fat and protein phases
(B) The continuous para-casein network
(C) The structural presence of large, macroscopic air pockets in the curd
(D) The complete dissolution of all colloidal calcium phosphate structures

2011

189. Why is measuring the "yield stress" of a dairy product often considered more relevant for consumer handling than measuring apparent viscosity at high shear?
(A) It determines if a product pours under its own weight or requires squeezing
(B) High shear viscosity is the primary physical parameter that strictly dictates final product color
(C) Yield stress calculations can be directly used to estimate the precise active microbial load
(D) High shear viscosity measurements represent an entirely theoretical and non-measurable construct

2022

190. Match the TPA parameters in List I with their corresponding definitions in List II:
List I: (TPA Parameters)
P. Hardness
Q. Adhesiveness
R. Cohesiveness
S. Springiness
List II: (Definitions)
1. Recovery distance between two consecutive compression cycles
2. Peak force during the first compression cycle
3. Negative force area during the upward withdrawal of the probe
4. Ratio of the positive force area of the second compression to the first
(A) P-2, Q-3, R-4, S-1
(B) P-1, Q-4, R-2, S-3
(C) P-3, Q-1, R-4, S-2
(D) P-2, Q-4, R-3, S-1

2015

191. Which specific defect in UHT milk is caused by age gelation?
(A) The spontaneous biological development of a highly sweet sugar flavor
(B) The gradual, progressive loss of apparent shear viscosity over storage time
(C) Irreversible network formation yielding a pudding-like consistency
(D) The immediate and catastrophic phase inversion of the emulsified milk fat

2014

192. What structural element is primarily responsible for the high elasticity (springiness) of Swiss cheese?
(A) The mechanical presence of large trapped whey pocket reservoirs
(B) The extensive, uncontrolled coalescence of individual fat droplets
(C) An intact casein network with distinct gas eyes
(D) Extreme, rapid acid-induced proteolysis during early cheese storage

2012

193. Which equation is best suited to describe the viscosity of a highly concentrated dairy suspension where particle-particle interactions are dominant?
(A) The classical, infinitely dilute Einstein viscosity equation
(B) The Krieger-Dougherty equation
(C) Stokes' law
(D) Poiseuille's law

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solubilization of all native whey proteins within the milk serum
(B) The highly rapid mechanical expansion of incorporated air bubbles during whipping
(C) The instantaneous physical crystallization of soluble lactose sugars in the serum
(D) Aggregation and cross-linking of destabilized casein micelles into a network that entraps water

2015

224. How does the concept of "hydrodynamic volume" relate to the thickening power of a dairy stabilizer like guar gum?
(A) The specific hydrodynamic volume directly dictates the exact final color profile of the active stabilizer
(B) A significantly smaller hydrodynamic volume paradoxically results in a much higher yield stress value
(C) Larger fully hydrated polymer volume restricts water mobility more, raising bulk viscosity
(D) Hydrodynamic volume represents a physical parameter that strictly measures the density of the dry powder

2013

225. Match the tribological application in List I with the sensory attribute it most accurately predicts in dairy products in List II:
List I: (Tribological Application)
P. High boundary friction
Q. Very low mixed regime friction
R. Thick hydrodynamic film
S. Depletion of salivary film
List II: (Sensory Attributes)
1. Creaminess/Smoothness
2. Astringency
3. Bulk thickness/Coating
4. Roughness/Chalkiness
(A) P-4, Q-1, R-3, S-2
(B) P-1, Q-4, R-2, S-3
(C) P-2, Q-3, R-1, S-4
(D) P-3, Q-2, R-4, S-1

2009

226. What physical process is responsible for the phenomenon known as "rheopexy" in certain specialized dairy dispersions?
(A) Shear-induced structural breakdown and progressive loss of physical viscosity
(B) Temperature-induced protein denaturation and subsequent chemical cross-linking
(C) Gravitational settling of dense, highly insoluble calcium phosphate particles
(D) Shear-induced structural buildup over time, raising apparent viscosity

2011

227. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): Microstructural imaging via SEM requires careful sample preparation, such as critical point drying, for high-moisture dairy gels.
Reason (R): High vacuum conditions inside the SEM chamber would cause rapid water evaporation, leading to severe structural collapse and artifacts if the water is not properly removed or immobilized beforehand.
Which of the following is correct?
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2004

228. Which characteristic of an emulsifier is strictly defined by Bancroft's rule?
(A) Its average molecular weight and specific overall chemical backbone structure
(B) Its thermal stability under pasteurization conditions
(C) Its solubility phase dictating the emulsion's continuous phase
(D) Its mechanical ability to form a stable foam structure

2016

229. What is the defining characteristic of a "dilatant" dairy fluid?
(A) Its apparent viscosity increases as the applied shear rate increases
(B) Its apparent viscosity decreases continuously as the applied shear rate increases over time
(C) It exhibits a massive yield stress
(D) It recovers its structure instantly upon removing shear

2001

230. In the formulation of a complex dairy dessert, why might a blend of kappa-carrageenan, locust bean gum, and mono/diglycerides be utilized?
(A) To strictly force the rapid, uncontrolled physical crystallization of native lactose sugars

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(C) The specific concentration of native beta-lactoglobulin in the serum phase
(D) The ratio of solid fat crystals to liquid oil

2008

202. What happens to the textural parameters (e.g., hardness) of a natural cheese as it undergoes extensive proteolysis during extended ripening?
(A) Hardness decreases as the protein matrix is broken down
(B) Hardness continuously and steadily increases, eventually transforming the cheese into a highly rigid solid
(C) Hardness remains completely and entirely unaffected by any biochemical proteolysis pathways during storage
(D) The cheese curd instantly and completely reverts to a low-viscosity fluid milk state under ambient conditions

2019

203. Which parameter describes the tendency of a dairy liquid to "string out" or form long threads when stretched, characteristic of some melted Mozzarella?
(A) Thixotropy
(B) Extensional viscosity
(C) Yield stress
(D) Hydrodynamic lubrication

2011

204. How does the presence of "free fat" (unemulsified fat) affect the foaming capacity of skim milk?
(A) It drastically and highly effectively improves foaming capacity by permanently stabilizing the air-water interface
(B) It depresses foaming by spreading over the interface and rupturing the protein film
(C) It physically causes the liquid skim milk matrix to spontaneously and instantly form a rigid three-dimensional gel
(D) It has absolutely and demonstrably zero measurable effect on the overall foaming capacity or stability parameters

2024

205. Why are parallel plate geometries often preferred over cone-and-plate geometries for testing dairy products with large particulates (like fruit yogurt)?
(A) The gap can be adjusted to be larger than the particulates, preventing jamming
(B) Because parallel plate geometries are structurally and mechanically incapable of performing rotation
(C) Because parallel plate systems strictly provide fundamental SI units, whereas cone-and-plate systems do not
(D) Because parallel plates are strictly limited to measuring purely linear Newtonian fluid behaviors

2003

206. Which tribological parameter is often used to predict the "astringency" or "mouth-drying" sensation of whey protein beverages?
(A) A highly sudden, progressive drop in the bulk apparent shear viscosity of the beverage
(B) A complete and instantaneous loss of the dynamic elastic storage modulus of the formulation
(C) Friction coefficient increase due to salivary boundary layer depletion
(D) The extremely rapid, shear-induced generation of a thick lubricating hydrodynamic film

2013

207. Match the dairy stabilizers in List I with their primary functional characteristics in List II:
List I: (Dairy Stabilizers)
P. Kappa-carrageenan
Q. High-methoxyl pectin
R. Sodium alginate
S. Xanthan gum
List II: (Functional Characteristics)
1. Reacts with calcium to form instant cold-setting gels
2. Forms weak thixotropic gels with casein, ideal for chocolate milk
3. Highly pseudoplastic, cold-soluble, excellent for suspending particles
4. Protects proteins from acid-induced aggregation via steric hindrance
(A) P-2, Q-4, R-1, S-3
(B) P-1, Q-3, R-2, S-4
(C) P-3, Q-1, R-4, S-2
(D) P-2, Q-1, R-3, S-4

2001

208. Which fundamental equation relates the shear stress to the shear rate for an ideal Bingham plastic fluid?
(A) $\sigma = \eta\dot{\gamma}$
(B) $\sigma = K\dot{\gamma}^n$
(C) $\sigma = \sigma_0 + \eta_p\dot{\gamma}$
(D) $\ln(\sigma) = \ln(K) + n\ln(\dot{\gamma})$

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ANSWERS

1. (A) The velocity gradient between adjacent flowing fluid layers
Shear rate represents the rate at which progressive shearing deformation is applied to a fluid. In dairy rheology, this parameter is physically defined as the gradient of velocity between adjacent flowing layers of the liquid. It quantifies how fast the fluid layers slide past one another under the influence of an applied external shear force.

2. (C) Elasticity
Elasticity is the rheological property where a material stores energy during deformation and recovers its original shape completely when the applied stress is removed. This behavior is typical of solid-like dairy structures like cheese at low temperatures. It contrasts with viscous behavior, where energy is dissipated as heat, leading to permanent deformation.

3. (A) Stress is the force applied per unit area, whereas strain is the resulting relative deformation
Mechanical evaluation of semi-solid dairy systems requires defining load and deformation. Stress is the internal force acting per unit area within the product structure, resulting from an applied force. Conversely, strain is the quantitative measure of the resulting physical deformation or change in dimensions, expressed relative to the initial size of the material.

4. (D) Plasticity
Plasticity describes materials that exhibit solid-like behavior under low stresses but transition to fluid-like flow once a threshold yield stress is exceeded. Butter exhibits this characteristic, maintaining its solid structure under gravity but flowing smoothly when spread with a knife. This property is crucial for the spreadability and structural retention of fat-crystal networks.

5. (B) Purely viscous liquids dissipate all imparted energy as heat during flow
Viscous materials and viscoelastic materials handle mechanical energy differently during deformation. A purely viscous liquid dissipates all the energy imparted to it during flow as thermal energy, resulting in permanent deformation. In contrast, viscoelastic dairy systems store a portion of the input energy elastically, allowing partial structural recovery after the removal of the applied stress.

6. (C) It remains constant across all shear rates for any dairy emulsion
Apparent viscosity represents the ratio of shear stress to shear rate under steady-state flow conditions. For non-Newtonian dairy emulsions, this parameter is not a constant value but changes continuously as the shear rate is altered. This variation occurs because the internal structure, such as droplets or protein networks, rearranges or breaks down under changing shear rates.

7. (D) Fracture stress
Large deformation testing of solid foods involves evaluating materials beyond their elastic limits. Fracture stress is the specific parameter that defines the force per unit area at which a cheese specimen exhibits macroscopic structural failure or tearing. This property is highly indicative of the structural integrity of the underlying casein-calcium phosphate matrix in ripened cheeses.

8. (A) Skim milk
Newtonian fluids maintain a constant dynamic viscosity regardless of the shear rate applied, representing a linear relationship between shear stress and shear rate. Skim milk behaves as a Newtonian fluid because it is a dilute system containing small, spherical, and non-interacting components in an aqueous phase. Higher-fat dairy systems or gelled products display non-Newtonian flow behaviors.

9. (B) Disruption of protein aggregates and alignment of asymmetric macromolecules under shear reduces flow resistance
Concentrated sweetened condensed milk contains a high volume fraction of milk solids and sugars, creating complex molecular assemblies. When sheared, these asymmetric macromolecules and protein aggregates align parallel to the flow direction, and weakly bonded structures are disrupted. This structural rearrangement reduces

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48. (D) Whey proteins denature salivary proteins, breaking the boundary layer
Astringency in acidic whey protein beverages is closely linked to increased friction in oral tribological measurements. This sensation occurs because the proteins interact with and precipitate salivary proteins, particularly proline-rich proteins. This precipitation disrupts the natural lubricating boundary layer on oral tissues, increasing the coefficient of friction and causing a rough sensation.

49. (A) Confocal Laser Scanning Microscopy (CLSM)
Confocal Laser Scanning Microscopy is a highly effective optical imaging technique for evaluating dairy microstructures. It utilizes a laser light source and specific fluorescent dyes to acquire thin, in-focus optical sections from thick specimens. This capability allows for the non-destructive three-dimensional reconstruction of fat and protein phases in emulsions.

50. (C) Sample preparation can significantly alter native structure
Conventional Scanning Electron Microscopy operates under high vacuum and requires extensive sample preparation, including chemical fixation and dehydration. For high-moisture dairy products like fresh yogurt, these preparation steps can cause significant structural shrinkage and artifacts. Consequently, the observed microstructural network may not accurately represent the native state of the gel.

51. (A) Transmission Electron Microscopy (TEM)
Transmission Electron Microscopy offers the highest theoretical resolution and magnification among standard microscopy techniques. It achieves this by passing an electron beam through an ultra-thin specimen. This capability makes TEM ideal for observing macromolecular structures, such as individual casein micelles, sub-micelles, and localized protein-lipid interactions in dairy matrices.

52. (D) By utilizing specific fluorescent dyes for different phases
Confocal Laser Scanning Microscopy distinguishes between different phases in a complex cheese matrix by using specific fluorescent dyes. For example, lipid-soluble dyes stain the fat phase, while protein-reactive dyes stain the casein network. The microscope detects the distinct emission wavelengths of these dyes, allowing researchers to map the spatial distribution of each phase.

53. (B) Butter where aqueous droplets are dispersed in milk fat
Butter is a classic example of a water-in-oil emulsion, where water droplets are dispersed within a continuous phase of liquid and crystalline milk fat. This structure is formed during the churning of cream, which induces a phase inversion from an oil-in-water system to a water-in-oil system, trapping the aqueous phase.

54. (C) An emulsion where dispersed droplets contain smaller droplets
Multiple emulsions are complex polydisperse systems where the dispersed droplets themselves contain smaller encapsulated droplets of a different phase. Common examples include water-in-oil-in-water (W/O/W) emulsions. These systems are utilized in advanced dairy formulations to protect sensitive nutrients, control flavor release, or develop reduced-fat products.

55. (D) Bancroft's Rule
Bancroft's Rule is a fundamental empirical rule in colloid chemistry that dictates emulsion type. It states that the phase in which an emulsifier is more soluble will constitute the continuous phase of the emulsion. Therefore, water-soluble emulsifiers favor oil-in-water emulsions, whereas oil-soluble emulsifiers favor the formation of water-in-oil emulsions.

56. (A) Water-in-oil (W/O) emulsion
The Hydrophilic-Lipophilic Balance (HLB) scale classifies surfactants based on their affinity for oil or water. Low HLB values, typically ranging from three to six, indicate that the emulsifier is highly lipophilic or oil-soluble. According to Bancroft's rule, these low HLB surfactants are most suitable for producing stable water-in-oil emulsions, such as butter.

57. (A) II, III, I, IV
The structural destabilization of an oil-in-water dairy emulsion typically begins with flocculation, where droplets aggregate. These aggregates then undergo creaming, migrating to the top due to density differences. Next, the closely packed droplets experience coalescence, merging to

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19. (A) Viscosity decreases exponentially as temperature increases
In Newtonian dairy fluids like pasteurized skim milk, increasing the temperature decreases viscosity exponentially. This behavior is typically modeled using the Arrhenius relationship, where higher thermal energy increases the kinetic energy of water molecules and soluble solids. This increased molecular motion reduces the intermolecular cohesive forces, thereby facilitating easier flow and lowering viscosity.

20. (B) I and III
Temperature effects on fluid viscosity are commonly modeled using the Arrhenius relationship. Increasing the concentration of total solids in dairy suspensions increases apparent viscosity because of the higher volume fraction of particles. However, thixotropic fluids are highly sensitive to shear history, and changes in the physical state of milk fat significantly impact cream rheology.

21. (B) Einstein equation
The Einstein equation is a fundamental mathematical model used to predict the viscosity of highly dilute suspensions containing spherical, non-interacting particles. In dairy science, it applies to very dilute whey or milk systems, estimating viscosity based solely on the volume fraction of the dispersed particles and the viscosity of the continuous phase.

22. (C) To account for hydrodynamic interactions between protein particles
The basic Einstein equation is restricted to highly dilute suspensions where dispersed particles do not interact. In semi-dilute dairy systems like concentrated skim milk, the higher concentration of casein micelles leads to significant hydrodynamic and electrostatic interactions. Modifications are necessary to account for these cooperative effects and the crowding of particles as volume fraction increases.

23. (D) Apparent viscosity tends toward infinity, causing solid-like behavior
As the volume fraction of dispersed particles in a dairy suspension approaches the maximum packing fraction, the particles become tightly crowded. Consequently, the apparent viscosity of the system increases dramatically and tends toward infinity. Under these conditions, the suspension transitions from a flowing liquid to a highly structured system exhibiting solid-like mechanical behavior.

24. (A) Highly irregular shape of the particles
Aside from the volume fraction, particle morphology strongly influences the rheological properties of concentrated dairy suspensions. Highly irregular, non-spherical particles increase viscosity significantly compared to spherical particles. This increase occurs because irregular shapes promote greater spatial obstruction, increase the effective hydrodynamic volume, and enhance physical collisions and entanglement during flow.

25. (A) P-3, Q-4, R-2, S-1
Dynamic viscoelasticity characterizes materials under oscillatory shear. The storage modulus represents the elastic energy stored per cycle, while the loss modulus quantifies the viscous energy dissipated as heat. Complex viscosity measures the total resistance to dynamic flow, and the phase angle ($\tan\delta$) represents the ratio of the viscous to elastic response.

26. (B) The material exhibits strong elastic characteristics
In dynamic oscillatory testing, the phase angle ($\tan\delta$) represents the ratio of viscous to elastic behavior. A very low phase angle, approaching zero degrees, indicates that the storage modulus dominates over the loss modulus. Consequently, the material behaves primarily as an elastic solid, storing deformation energy and recovering its shape efficiently.

27. (A) Complex viscosity incorporates both elastic and viscous responses under dynamic testing
Complex viscosity is determined through dynamic oscillatory testing and incorporates both the elastic and viscous responses of a viscoelastic material. Conversely, apparent viscosity is measured under steady-state rotational shear and reflects only the viscous resistance to flow. This distinction makes complex viscosity highly valuable for evaluating the structural properties of delicate dairy gels.

28. (C) Determining storage modulus with a rheometer
Fundamental rheological measurements quantify well-defined physical properties that are independent of the testing apparatus. Determining the storage modulus using a

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resistance to flow, causing the apparent viscosity to decrease as the shear rate increases.

10. (A) I and II
Dilatant fluids display shear-thickening behavior, where apparent viscosity increases with increasing shear rate. Bingham plastics represent viscoplastic materials that require a specific minimum threshold yield stress to be exceeded before they initiate macroscopic flow. Pseudoplastic fluids are shear-thinning and exhibit a decreasing apparent viscosity with increasing shear rate, rather than remaining constant.

11. (A) Herschel-Bulkley equation
Stirred yogurt is a complex, shear-thinning dairy fluid that requires a specific yield stress to initiate flow. The Herschel-Bulkley model is widely used to describe such systems because it mathematically incorporates a yield stress parameter along with a flow behavior index and consistency coefficient. This combination allows for accurate characterization of viscoplastic and shear-thinning behaviors.

12. (C) The fluid is dilatant
In the standard Power law model, the flow behavior index dictates the shear-rate dependence of viscosity. When this index is greater than one, the fluid is classified as dilatant or shear-thickening, meaning its apparent viscosity increases as the shear rate rises. This behavior occurs in highly concentrated suspensions where particles jam under shear.

13. (D) Casson equation
The Casson model is highly suitable for characterising the rheological behavior of molten chocolate and structured dairy-based chocolate coatings. This equation accurately predicts the yield stress and plastic viscosity of the suspension, which are critical for determining coating thickness and flow behavior. It effectively models the interactive particle networks formed by sugar, cocoa, and fat.

14. (C) It inherently lacks a yield stress term for predicting flow initiation
Concentrated dairy gels typically require a threshold force, or yield stress, to be exceeded before they begin to flow. The simple Power law model is limited when applied to these systems because it lacks a mathematical term for yield stress. Consequently, it cannot accurately predict flow initiation or model the viscoplastic behavior of gels.

15. (A) Both A and R are true and R is the correct explanation of A.
Thixotropy is a time-dependent rheological property where apparent viscosity decreases under constant shearing and recovers when the shear stops. This behavior occurs because continuous shearing physically breaks down the weak, reversible microstructural networks of the dairy matrix over time. As these structural linkages are disrupted, the material offers progressively less physical resistance to flow.

16. (D) Rheopexy
Rheopexy represents a rare rheological phenomenon where a fluid exhibits a time-dependent increase in apparent viscosity under a constant shear rate. This behavior is the exact opposite of thixotropy, where viscosity decreases over time under shear. It occurs when mild, continuous shear promotes the formation of a structural network rather than causing structural destruction.

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17. (A) Rebuilding of the broken casein micelle network over time
After the cessation of shearing, thixotropic dairy products like set yogurt gradually regain their original structure and viscosity. This physical recovery is driven by the gradual rebuilding of the disrupted casein micelle network through weak, reversible interactions. This slow, time-dependent structural reconstruction is a defining characteristic of thixotropic materials, distinguishing them from permanently damaged gels.

18. (C) Thixotropy is time-dependent, whereas shear-thinning is instantaneous
Shear-thinning (pseudoplasticity) and thixotropy both involve a decrease in viscosity under shear, but they differ fundamentally in their time-dependence. Shear-thinning is an instantaneous response to changes in shear rate, with viscosity adjusting immediately. Conversely, thixotropy is a time-dependent process, where the structural breakdown and viscosity reduction progress continuously over a period of sustained shearing.

38. (C) It increases fracture stress but reduces fracture strain
Lowering the temperature of Cheddar cheese immobilizes the fat phase and solidifies the fat crystals within the matrix. This physical transition increases the overall rigidity of the cheese, resulting in a higher fracture stress. However, the solidified structure becomes more brittle and less deformable, which significantly reduces the fracture strain before macroscopic failure occurs.

39. (D) The peak force recorded during the first compression cycle
Texture Profile Analysis utilizes a double-compression cycle to evaluate the mechanical behavior of foods. From the resulting force-time curve, hardness is defined as the maximum peak force recorded during the first compression. This parameter represents the force required to deform the paneer sample to the specified target depth.

40. (A) Both A and R are true and R is the correct explanation of A.
Cohesiveness in Texture Profile Analysis is determined by calculating the ratio of the work done during the second compression to that of the first compression. This parameter measures how well the internal structure of the dairy product resists damage during a second deformation relative to its initial state, reflecting structural integrity.

41. (B) Springiness
Chewiness is a secondary parameter calculated in Texture Profile Analysis for solid, viscoelastic foods like Mozzarella cheese. It is mathematically defined as the product of hardness, cohesiveness, and springiness. This parameter represents the energy required to masticate the solid food product to a state ready for swallowing.

42. (B) The negative work required to pull the probe away from the cheese surface
Adhesiveness in Texture Profile Analysis represents the surface properties of sticky materials like processed cheese spreads. It is quantified as the negative work area on the force-time curve, which represents the energy required to overcome the attractive forces between the product surface and the probe as the probe is withdrawn.

43. (A) The study of friction, wear, and lubrication of foods
Food tribology is the study of friction, wear, and lubrication during the relative motion of interacting surfaces. When applied to dairy products, it evaluates the behavior of thin fluid films between the tongue and palate. This discipline is critical for understanding the sensory perception of texture, smoothness, and fat-like mouthfeel.

44. (C) Direct surface contact where friction depends on surface properties
The boundary lubrication regime of the Stribeck curve occurs at low entrainment speeds or high loads. In this regime, the thin dairy film is squeezed out, leading to direct contact between the sliding solid surfaces. Consequently, the coefficient of friction is relatively high and depends primarily on the surface properties and boundary-lubricating molecules.

45. (D) Hydrodynamic lubrication
In the hydrodynamic lubrication regime, the sliding surfaces are completely separated by a continuous, thick fluid film of the dairy product. The pressure generated within this film is sufficient to support the entire applied load. Under these conditions, friction is independent of surface properties and is determined solely by the bulk viscosity of the fluid.

46. (C) It lowers the coefficient of friction in the mixed lubrication regime
Increasing the fat content of milk introduces fat globules that act as effective lubricants between sliding surfaces. In the mixed lubrication regime, these fat droplets coalesce and form a thin lubricating film on the surfaces. This localized film formation significantly reduces the coefficient of friction compared to low-fat or skim milk.

47. (B) P-4, Q-1, R-3, S-2
Creaminess is associated with low friction in the mixed lubrication regime. Astringency involves salivary protein precipitation, which increases friction. Firmness correlates with a high bulk fracture stress under uniaxial compression. Spoonability is determined by viscoelastic parameters, specifically a high loss modulus and moderate yield stress at room temperature.

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and more fragile, eventually leading to bubble coalescence and foam collapse.

87. (D) Rennet gels have coarse strands, while acid gels form compact clusters
Rennet-induced gels and acid-induced gels exhibit distinct microstructures. Rennet gels, formed by the specific enzymatic cleavage of chymosin, consist of a coarse, spatial network composed of thick protein strands with large interstitial pores. In contrast, acid gels, formed near the isoelectric point, consist of a more particulate network of compact casein clusters with smaller pores.

88. (A) Serrated parallel plates
Viscous, semi-solid dairy foods like processed cheese can undergo wall slip when measured with smooth geometries. To prevent this measurement artifact at high temperatures, serrated or roughened parallel plates are preferred. The textured surface of these plates grips the sample securely, ensuring that the applied deformation is fully transmitted through the bulk material.

89. (B) Extrudability
Extrudability is an empirical rheological parameter that measures the force required to compress and discharge a product through an orifice. In dairy products like sour cream or cheese spreads, this parameter correlates directly with yield stress and consistency, reflecting how easily a consumer can squeeze the product out of its packaging.

90. (A) II and IV
The hydrodynamic lubrication regime of the Stribeck curve is governed entirely by the bulk viscosity of the fluid, making the first statement false. Additionally, the coefficient of friction is heavily influenced by fat content, as fat globules act as lubricants to reduce friction. Consequently, statement four is also incorrect under standard tribological principles.

91. (A) The product of hardness and cohesiveness
Gumminess is a secondary textural parameter derived from Texture Profile Analysis of semi-solid foods. It is mathematically defined as the product of hardness and cohesiveness. This parameter represents the energy required to disintegrate a semi-solid dairy food, such as paneer or cream cheese, to a state where it is ready for swallowing.

92. (C) Because structural rupture follows reaction kinetics
The progressive structural breakdown of thixotropic dairy fluids under shear is a time-dependent process. This structural degradation can be mathematically modeled using kinetic decay equations because the rate of structural rupture follows chemical reaction kinetics. These models utilize a structural parameter to describe the transition from an undamaged state to a fully sheared state.

93. (D) Kinematic viscosity incorporates the fluid's density
Dynamic viscosity measures the internal resistance of a fluid to flow under an applied shear force. Kinematic viscosity, conversely, is defined as the ratio of dynamic viscosity to the density of the fluid. This parameter represents the resistance of a liquid to flow under the influence of gravity, which is highly relevant for capillary viscometry.

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94. (C) The native Milk Fat Globule Membrane (MFGM)
In raw, unhomogenized milk, fat globules are stabilized against coalescence by the native Milk Fat Globule Membrane. This complex membrane consists of a phospholipid bilayer, glycoproteins, and enzymes. It provides both steric hindrance and electrostatic repulsion between adjacent globules, preventing them from merging and maintaining the physical stability of the raw emulsion.

95. (B) Network shrinkage caused by dehydration
When preparing high-moisture acid-induced dairy gels for Scanning Electron Microscopy, researchers must dehydrate the samples. This dehydration process can cause significant physical shrinkage and distortion of the delicate protein network. To minimize these artifacts, specialized drying techniques, such as critical point drying or freeze-drying, are necessary to preserve the native pore structure.

96. (D) Hookean elastic behavior
Hookean elastic behavior is defined by a linear relationship where the applied mechanical stress is directly proportional to the resulting strain, up to the material's proportional limit. This behavior represents ideal elasticity, where all energy is stored and recovered. Solid-like dairy

form larger droplets. Finally, complete phase separation occurs, resulting in visible oiling off.

58. (B) By adsorbing at the interface of the two phases
Emulsifiers are amphiphilic molecules containing both hydrophilic and lipophilic groups. They stabilize dairy emulsions by adsorbing at the oil-water interface, positioning their hydrophobic tails in the lipid phase and their hydrophilic heads in the aqueous phase. This adsorption significantly reduces the interfacial tension, thereby lowering the thermodynamic energy required to maintain the emulsion.

59. (A) Creaming
Creaming is an emulsion destabilization mechanism driven by gravitational or centrifugal forces. It involves the upward migration of dispersed lipid droplets to the top of the container because the density of milk fat is lower than that of the aqueous continuous phase. This process results in a highly concentrated cream layer at the surface.

60. (A) Both A and R are true and R is the correct explanation of A.
Flocculation is a reversible destabilization process in dairy emulsions because the aggregated droplets do not merge. The individual interfacial films surrounding each droplet remain intact, holding them together in weak clusters. Because the droplets do not coalesce, mild agitation can easily disrupt these weak bonds and successfully redisperse the droplets back into the continuous phase.

61. (D) Coalescence involves the irreversible merging of droplets into larger ones
Coalescence and flocculation represent distinct destabilization mechanisms in dairy emulsions. Flocculation involves the aggregation of droplets into clusters where each droplet retains its individual interface. Conversely, coalescence is an irreversible process where the interfacial film between contacting droplets ruptures, causing them to merge and form a single, larger droplet with a reduced surface area.

62. (C) Ostwald ripening
Ostwald ripening is a thermodynamic process that occurs in polydisperse dairy emulsions over time. It is driven by the difference in chemical potential between droplets of different sizes, caused by interfacial curvature. Consequently, soluble molecules diffuse from smaller droplets to larger ones, causing the small droplets to shrink and disappear while the larger droplets grow.

63. (B) A dispersion of gas bubbles in a continuous liquid phase
A dairy foam is a colloidal dispersion where gas bubbles, typically air, are dispersed within a continuous liquid or semi-solid phase containing proteins and lipids. The foam structure is stabilized by surface-active proteins that adsorb at the gas-liquid interface, forming a viscoelastic film that prevents bubble coalescence and liquid drainage.

64. (D) The percentage increase in volume due to air incorporation
Overrun is a critical physical parameter in ice cream manufacturing. It mathematically represents the percentage increase in the volume of the ice cream mix resulting from the incorporation of air bubbles during the freezing and whipping process. Proper control of overrun is essential for achieving the desired light texture and melting properties.

65. (A) II, IV, I, III
The formation of a stable dairy foam begins with the incorporation of macroscopic air bubbles into the liquid. These large bubbles are broken down into smaller, finely dispersed bubbles under shear. Simultaneously, surface-active proteins adsorb at the newly created air-water interface. Finally, these proteins unfold and cross-link to form a stable viscoelastic film.

66. (C) Laplace pressure
Laplace pressure describes the pressure difference between the inside and outside of a curved interface, such as a gas bubble. In dairy foams, this pressure is inversely proportional to the bubble radius, meaning smaller bubbles have higher internal pressure. This pressure gradient drives gas diffusion from small to large bubbles, contributing to disproportionation.

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67. (A) It stabilizes lamellae via surface tension gradients
The Gibbs-Marangoni effect is crucial for stabilizing dairy foams against rupture. When a thin liquid lamella between bubbles is stretched, the local concentration of surfactant decreases, raising the local surface tension. This gradient

rheometer under controlled conditions yields a fundamental viscoelastic property of the material. Conversely, techniques like penetrometers or consistometers yield empirical measurements that depend heavily on the specific geometry and conditions of the instrument.

29. (D) They are simpler, faster, and correlate well with sensory texture
Empirical rheological methods are widely used in commercial dairy plant quality control because of their practicality. These tests are generally simple to operate, require less expensive equipment, and provide rapid results. Furthermore, the empirical values obtained often correlate very well with human sensory perceptions of texture, such as the spreadability of butter.

30. (C) II and IV
Falling sphere viscometers are unsuitable for opaque dairy fluids because the falling sphere cannot be visually tracked. Orifice viscometers provide empirical, single-point measurements and cannot yield fundamental rheological parameters for non-Newtonian, pseudoplastic fluids. Conversely, capillary and rotational viscometers are capable of producing fundamental rheological data under controlled shear conditions.

31. (B) Poiseuille's law
Capillary viscometers operate based on the principles of fluid dynamics through narrow tubes. For Newtonian dairy liquids, the relationship between the volumetric flow rate, pressure drop, and tube dimensions is mathematically defined by Poiseuille's law. This physical principle allows for the accurate calculation of dynamic viscosity from gravity-driven flow measurements.

32. (D) It requires the liquid to be entirely transparent to track the sphere
A primary limitation of the falling sphere viscometer is its reliance on optical tracking to measure the terminal velocity of the sphere. Because thick dairy creams are opaque emulsions that scatter light, it is impossible to visually monitor the falling sphere. Consequently, this method is unsuitable for analyzing most concentrated dairy systems.

33. (A) The shear rate is uniform throughout the entire sample volume
In rheological testing, a cone-and-plate geometry offers a significant advantage over parallel plates because the shear rate remains uniform throughout the entire sample gap. This uniformity occurs because the angle of the cone compensates for the radial increase in linear velocity. It is highly beneficial for obtaining precise measurements of shear-sensitive dairy fluids.

34. (C) Yogurt containing fruit pieces
A parallel plate geometry is highly appropriate for testing dairy products that contain particulate matter, such as yogurt with fruit pieces. The gap between the plates can be adjusted to accommodate the particle size, preventing jamming and measuring artifacts. In contrast, narrow-gap geometries like cone-and-plate would experience severe particle interference.

35. (A) II, IV, I, III
At room temperature, whey is a highly dilute aqueous solution with the lowest viscosity. Whole milk has a slightly higher viscosity due to the presence of fat globules and protein micelles. Heavy whipping cream is more viscous because of its high fat content. Sour cream has the highest viscosity due to its acidified, gelled protein network.

36. (D) The strength of the casein-calcium phosphate network
The fracture stress of a ripened cheese under uniaxial compression represents the structural resistance of the material to macroscopic tearing. This parameter is directly determined by the density and strength of the cross-linked casein-calcium phosphate network. As proteolysis progresses during ripening, this protein matrix weakens, resulting in a corresponding decrease in fracture stress.

37. (B) The minimum force per unit area required to initiate flow
In the context of butter spreadability, yield stress is the minimum force per unit area that must be applied to the fat crystal network to initiate macroscopic flow. Below this threshold stress, butter behaves as an elastic solid, retaining its shape. Exceeding this value disrupts the crystalline network, allowing the product to be spread.

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77. (D) Kappa-carrageenan
Kappa-carrageenan is a sulfated galactan hydrocolloid extracted from red seaweed. It exhibits a unique, highly specific synergistic interaction with the positively charged regions of kappa-casein in milk. This interaction allows kappa-carrageenan to form a weak, stable gel network in dairy systems at very low concentrations, preventing phase separation without increasing bulk viscosity excessively.

78. (C) To form a weak thixotropic network that prevents cocoa settling
Kappa-carrageenan is added to chocolate milk at extremely low concentrations to prevent cocoa particles from settling. It interacts with milk caseins to form a weak, three-dimensional thixotropic gel network. This delicate network exhibits a yield stress sufficient to suspend the cocoa particles under static conditions, while remaining highly fluid and pourable under shear.

79. (B) Locust bean gum (LBG)
Locust bean gum is a non-ionic galactomannan polysaccharide extracted from the seeds of the carob tree. It consists of a mannose backbone with galactose side chains. LBG requires heating to approximately eighty degrees Celsius to achieve full hydration and viscosity, making it highly valuable for heat-shock resistance in frozen dairy desserts.

80. (C) I, II and III
Guar gum and locust bean gum are commonly blended in ice cream formulations. Guar gum provides cold-mix viscosity, while locust bean gum offers excellent heat-shock resistance after thermal activation. However, because both are non-gelling galactomannans, they can cause thermodynamic incompatibility and wheying-off. Kappa-carrageenan is added to prevent this phase separation by stabilizing casein.

81. (A) It adsorbs onto casein micelles to prevent aggregation
In acidified dairy beverages, high-methoxyl pectin is added to prevent the aggregation and precipitation of casein micelles near their isoelectric point. The negatively charged pectin molecules adsorb onto the positively charged regions of the casein micelles. This adsorption provides steric and electrostatic stabilization, keeping the protein particles suspended and preventing sedimentation.

82. (C) Its ability to form gels in the presence of calcium ions
Sodium alginate is a linear polysaccharide that forms strong, heat-stable gels in the presence of divalent cations like calcium. This gelation occurs via the "egg-box" model, where calcium ions cross-link the guluronic acid blocks. This property is exploited in the food industry to produce structured or spherified dairy inclusions.

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83. (A) Emulsifiers manage interfaces, while stabilizers manage viscosity
Emulsifiers and stabilizers serve complementary functional roles in complex dairy matrices. Emulsifiers are surface-active molecules that lower interfacial tension, modify fat crystallization, and control fat-protein interactions at interfaces. In contrast, stabilizers are hydrophilic macromolecules that increase the viscosity of the continuous phase, reducing water mobility and retard physical destabilization processes like creaming.

84. (D) To sequester calcium and allow proteins to act as emulsifying agents
Melting salts, such as sodium phosphates and citrates, are essential in processed cheese manufacturing. They function by sequestering calcium ions from the insoluble calcium-paracaseinate network. This calcium depletion solubilizes the caseins, converting them into highly functional sodium-caseinate. These solubilized proteins can then act as effective emulsifiers to stabilize the milk fat.

85. (A) P-3, Q-4, R-1, S-2
Newtonian fluids show direct proportionality between shear stress and shear rate. The Power law model represents a curvilinear relationship without yield stress. The Herschel-Bulkley model incorporates a yield stress followed by shear-thinning or thickening behavior. The Casson model is a specific yield-stress model widely applied to characterize chocolate and cocoa flow characteristics.

86. (C) Liquid drainage
Liquid drainage is a critical phase in dairy foam destabilization. It is driven by gravity and capillary pressure, which force liquid to flow through the thin lamellae and plateau borders between bubbles. As this drainage progresses, the liquid films become progressively thinner

drives the flow of liquid and surfactant back to the thinned region, restoring the film thickness and preventing bubble collapse.

68. (D) It resists forces that would rupture the bubble lamellae
A strong viscoelastic interfacial protein film is essential for maintaining foam stability in whipped cream. This rigid film provides mechanical resistance against the stretching and thinning forces that act on the liquid lamellae between bubbles. By resisting these deformations, the viscoelastic interface prevents the coalescence of gas bubbles and retards overall foam drainage.

69. (B) Solubilization of colloidal calcium phosphate and reduction of electrostatic repulsion
Acid-induced gelation in yogurt manufacture is driven by the progressive lowering of pH by lactic acid bacteria. This acidification solubilizes the colloidal calcium phosphate within casein micelles and neutralizes their negative surface charge. As the pH approaches the isoelectric point of casein, electrostatic repulsion decreases, allowing hydrophobic interactions to dominate and form a gel network.

70. (C) I and II
Rennet-induced gelation begins with the enzymatic cleavage of the Phe105-Met106 bond of kappa-casein by chymosin, releasing the hydrophilic glycomacropeptide. The secondary phase involves the calcium-mediated aggregation of the resulting para-kappa-casein micelles. This specific enzymatic process is highly dependent on calcium ions and is inhibited under highly alkaline pH conditions.

71. (D) Heat gelation requires protein unfolding to expose reactive groups, while rennet relies on enzymatic cleavage
Heat-induced gelation of whey proteins requires thermal denaturation, which unfolds the globular proteins to expose reactive hydrophobic and sulfhydryl groups that subsequently form disulfide cross-links. In contrast, rennet-induced gelation of casein relies on the specific enzymatic cleavage of kappa-casein by chymosin, destabilizing the micelles and allowing them to aggregate in the presence of calcium.

72. (A) Disulfide binding of beta-lactoglobulin to kappa-casein
Heating milk prior to yogurt fermentation denatures whey proteins, primarily beta-lactoglobulin. The unfolded beta-lactoglobulin interacts with kappa-casein on the surface of casein micelles through disulfide exchange, forming a covalent complex. This interaction increases the effective volume fraction of the micelles, leading to a firmer gel structure and reduced syneresis in the final yogurt.

73. (B) They promote controlled partial coalescence during freezing
Mono- and diglycerides are small-molecule surfactants added to ice cream mixes to displace proteins from the fat globule surface. This displacement weakens the protein membrane, promoting controlled partial coalescence of the fat globules during the freezing and shearing process. This partially aggregated fat network stabilizes air bubbles and improves the melting resistance.

74. (B) Phospholipid
Lecithin is a naturally occurring zwitterionic phospholipid found in milk fat globule membranes and egg yolks. Structurally, it consists of glycerol esterified with two fatty acids and a phosphorylcholine group. This amphiphilic structure makes lecithin an effective natural emulsifier, widely used in dairy formulations to stabilize emulsions and improve dispersibility.

75. (C) A is true but R is false.
Polysorbates like Tween 80 are highly effective at promoting overrun and partial coalescence in ice cream. However, they are hydrophilic emulsifiers with high HLB values, not lipophilic ones. They function by actively displacing proteins from the fat globule surface because of their high surface activity, rather than dissolving entirely within the bulk fat phase.

76. (C) It acts as an emulsifier interacting with proteins and starches
Sodium Stearoyl Lactylate is an anionic, food-grade emulsifier commonly used in dairy-based bakery fillings. It functions by interacting with both starch fractions and proteins, forming stable complexes that enhance viscosity and water retention. This dual interaction improves the emulsion stability, prevents syneresis, and maintains a smooth texture in the filling.

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products, such as cold butter or cheese, exhibit this response under small deformations.

97. (A) It tracks elastic-to-viscous transitions
The phase angle ($\tan\delta$) in dynamic oscillatory testing indicates the relative balance between viscous and elastic behaviors. Measuring this parameter in ripening cheese is highly significant because it tracks the structural transitions from a highly elastic solid to a more viscous, meltable state, which is driven by enzymatic proteolysis and fat liquefaction.

98. (C) Sweetened condensed milk – Plastic
Sweetened condensed milk is a concentrated liquid dairy product that typically exhibits shear-thinning (pseudoplastic) flow behavior rather than plastic behavior. It does not possess a significant yield stress at room temperature, which is a defining characteristic of plastic materials. Skim milk, Cheddar cheese, and stirred yogurt are all paired correctly with their classifications.

99. (A) It disrupts fat globules to increase surface area
High-pressure homogenization increases the viscosity and stability of cream by physically disrupting the fat globules into much smaller sizes. This size reduction vastly increases the total surface area of the lipid phase. Casein micelles and whey proteins then rapidly adsorb onto this new interface, increasing the effective volume fraction and stabilizing the emulsion.

100. (A) II, III and IV
Stabilizers are large, hydrophilic carbohydrate polymers that function primarily by increasing the viscosity of the continuous aqueous phase of dairy emulsions. This viscosity increase immobilizes water, reducing the velocity of droplet movement and providing kinetic stability against creaming. Unlike true emulsifiers, they do not significantly lower interfacial tension or adsorb directly at the interface.

101. (B) Crystallization and growth of lactose
The sensory defect of sandiness in ice cream is caused by the crystallization and progressive growth of alpha-lactose monohydrate crystals over time. This crystallization occurs when lactose exceeds its solubility limit during storage, especially under temperature fluctuations. If the crystals grow larger than approximately fifteen micrometers, they become detectable as a gritty texture in the mouth.

102. (C) Contraction of the casein network to squeeze out whey
Syneresis is a common defect in set yogurt that involves the spontaneous expulsion of whey from the gel structure. This phenomenon is driven by the slow contraction of the three-dimensional casein micelle network. As the protein strands draw closer together, the entrapped aqueous phase is squeezed out, resulting in a layer of whey on the surface.

103. (D) The deformation at structural failure
In large deformation mechanical testing of solid dairy products like butter, fracture strain is defined as the relative deformation or displacement at which macroscopic structural failure occurs. It indicates the limit of extensibility or compressibility of the fat crystal network before the sample cracks or breaks, reflecting the brittleness of the product.

104. (A) Dehydration of casein micelles
The alcohol stability test measures the colloidal stability of milk proteins. Adding ethanol to milk lowers the dielectric constant of the solvent and dehydrates the hydrophilic outer layer of the casein micelles, particularly the kappa-casein brush. This dehydration reduces steric and electrostatic stabilization, causing the micelles to aggregate and precipitate if the milk is unstable.

105. (A) Both A and R are true and R is the correct explanation of A.
Pseudoplastic dairy fluids exhibit shear-thinning behavior, where apparent viscosity decreases as the shear rate increases. This phenomenon is explained by the progressive alignment of asymmetric proteins, fat aggregates, or polymer chains with the lines of flow. This structural orientation reduces hydrodynamic drag and internal frictional resistance, facilitating easier flow under higher shearing forces.

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106. (B) The blend offers better functional balances for fat agglomeration
A blend of mono- and diglycerides is often preferred in ice cream manufacturing because it provides an optimal balance of hydrophilic and lipophilic properties. This synergistic combination allows for precise control over the displacement of proteins from the fat globule

surface, which is essential for promoting controlled partial coalescence and stabilizing the incorporated air bubbles.

107. (A) Low coefficient of friction
The sensory perception of smoothness in semi-solid dairy desserts correlates strongly with a low coefficient of friction during oral processing. When measured via tribology, a lower friction coefficient indicates that the product forms an effective, lubricating thin film between the sliding oral surfaces, preventing direct contact and yielding a smooth mouthfeel.

108. (C) Non-uniform shear rate across the gap
A primary limitation of using a simple rotational viscometer with a standard spindle for non-Newtonian fluids is the non-uniform shear rate within the sample. Because the fluid gap is not strictly controlled, the shear rate varies with distance from the spindle. This variation makes it impossible to define a single, precise shear rate for calculations.

109. (D) Churning of cream into butter
The manufacture of butter from cream relies on the application of high mechanical shear stress during churning. This aggressive physical action ruptures the fat globule membranes, releasing liquid fat. The liberated fat acts as a cement, binding the remaining fat crystals and droplets together to induce a complete phase inversion from oil-in-water to water-in-oil.

110. (C) Permanent viscous deformation
In a creep-recovery rheological test, a constant stress is applied to a cheese sample and then removed. The resulting strain recovery profile is monitored over time. The non-recoverable portion of the strain at the end of the recovery phase represents the permanent, viscous deformation, indicating the fluid-like flow behavior of the viscoelastic material.

111. (B) Tiu-Boger model
The Tiu-Boger model is a rheological model designed to describe the flow behavior of thixotropic fluids. It mathematically incorporates a structural parameter that decays over time under constant shearing, representing the kinetics of structural breakdown. This model is highly effective for characterizing time-dependent viscosity changes in sheared dairy gels like stirred yogurt.

112. (D) Sucrose binds free water, increasing the biopolymer volume fraction
Adding sucrose to dairy formulations significantly alters their rheological properties by binding a large portion of the free water. This hydration effect increases the effective concentration and volume fraction of the remaining proteins and hydrocolloids. Consequently, the steric interactions between molecules increase, leading to a marked rise in the apparent viscosity of the system.

113. (A) A Bingham plastic exhibits linear flow behavior once its yield stress is exceeded, whereas a pseudoplastic fluid exhibits shear-thinning without a yield stress
Bingham plastics and pseudoplastics represent distinct non-Newtonian behaviors. A Bingham plastic requires a specific yield stress to be exceeded before it initiates flow, after which it exhibits a linear relationship between stress and shear rate. In contrast, a pseudoplastic fluid exhibits shear-thinning immediately upon the application of stress, without requiring a threshold yield stress.

114. (C) The distance the sample recovers its height between compression cycles
Springiness is an instrumental parameter measured in Texture Profile Analysis of viscoelastic foods like cheese. It is quantified as the distance or height to which the sample recovers its original dimensions between the end of the first compression cycle and the start of the second compression cycle, representing the elastic recovery.

115. (A) Entrainment of a thin fluid film
The transition from boundary to mixed lubrication during the oral processing of a dairy beverage is driven by the entrainment of a thin fluid film. As the sliding speed increases, the hydrodynamic pressure of the fluid forces the beverage into the contact zone, partially separating the oral surfaces and significantly reducing the coefficient of friction.

116. (C) Polysorbate 80 (Tween 80)
The Hydrophilic-Lipophilic Balance scale measures the hydrophilic or lipophilic nature of surfactants. Polysorbate eighty has a high value of fifteen, representing a highly hydrophilic nature. This makes it extremely effective at stabilizing oil-in-water emulsions where the continuous

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phase is water, preventing droplet aggregation by forming a robust protective barrier around dispersed oil droplets.

117. (A) Smaller droplets dissolve and redeposit onto larger droplets
Ostwald ripening is a thermodynamically driven destabilization process occurring in emulsions. It is characterized by the diffusion of dispersed phase molecules through the continuous phase from smaller to larger droplets. This phenomenon occurs because smaller droplets have a higher chemical potential and solubility than larger ones, causing them to dissolve and gradually redeposit.

118. (D) It depends on the applied mathematical model and the measurement timeframe
Yield stress is not an intrinsic material constant but rather an operational parameter. Its measured value in dairy suspensions varies significantly depending on the experimental shear rate history, the timescale of the measurement, and the specific rheological model applied. This dependency arises from the time-dependent structural breakdown and recovery of the weak colloidal protein network.

119. (B) Coagulation accelerates up to 40–45°C, above which chymosin begins to denature
Rennet coagulation involves enzymatic and non-enzymatic stages. The primary enzyme, chymosin, exhibits temperature-dependent kinetics. Increasing temperatures up to forty to forty-five degrees Celsius enhances the rate of enzymatically cleaving kappa-casein and subsequent hydrophobic micellar aggregation. However, exceeding this optimal thermal range leads to rapid denaturation and irreversible inactivation of the chymosin enzyme structure.

120. (A) P-2, Q-3, R-1, S-4
Characterizing food microstructure requires matching specific imaging techniques with sample requirements. Confocal laser scanning microscopy provides non-invasive optical sectioning of hydrated, stained specimens. Transmission electron microscopy yields ultra-high resolution of thin internal sections. Scanning electron microscopy resolves surface topography and three-dimensional dried features, while light microscopy provides basic, low-resolution observation with minimal preparation efforts.

121. (D) It increases exponentially, eventually surpassing the loss modulus (G')
During the acid-induced gelation of milk, the physical state transitions from a viscous liquid to an elastic solid network. This structural development is monitored using dynamic rheology. As caseins aggregate at their isoelectric point, the storage modulus increases dramatically by several orders of magnitude, eventually exceeding the loss modulus, which indicates dominant elastic gel behavior.

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122. (A) The degree of partial fat coalescence required to stabilize air bubbles
The overrun of whipped cream is limited by the structural mechanism of bubble stabilization. During whipping, a partially coalesced fat globule network must form at the air-water interface to trap air bubbles. Insufficient or excessive partial fat coalescence reduces the structural stability of the foam, directly constraining the maximum amount of air that can be incorporated.

123. (B) It lowers astringency by increasing viscosity and lubricating oral surfaces
Astringency is a tactile sensation caused by the precipitation of salivary proteins, which increases friction in the oral cavity. High-molecular-weight polysaccharides like guar gum increase the viscosity of dairy beverages. This rheological change enhances the lubrication of oral surfaces, masking the dryness and roughness by restoring a smooth sliding film between the tongue and palate.

124. (B) A thin, weak interfacial film that easily ruptures during collisions
Coalescence is the irreversible merging of two or more dispersed droplets into a single larger droplet. This process requires the physical rupture of the protective interfacial film surrounding the droplets. A thin, mechanically weak, or poorly covered interfacial film easily breaks during droplet collisions, promoting direct oil-to-oil contact and rapid coalescence over simple flocculation.

125. (A) Shear-thickening behavior
Highly concentrated whey protein isolate solutions subjected to extremely high shear rates can exhibit shear-thickening behavior, also known as dilatancy. Under severe mechanical stress, the closely packed protein molecules cannot slide past each other quickly enough,

162. (D) They displace proteins from fat globules, promoting partial coalescence to trap air
Polysorbates are small-molecule, surface-active emulsifiers used in ice cream manufacture. During the aging and freezing processes, they competitively displace milk proteins from the surface of fat globules, lowering interfacial stability. This displacement allows the fat globules to undergo controlled, partial coalescence during shearing, forming a structural fat network that stabilizes air bubbles and retards melting.

163. (A) It flows only after exceeding a yield stress, then behaves as a Newtonian fluid
A Bingham plastic is a specific type of viscoplastic fluid. Below a threshold stress level, the material behaves as a viscoelastic solid and does not flow. Once the applied shear stress exceeds this characteristic yield stress, the internal structure breaks down completely, and the material flows, exhibiting a linear relationship between shear stress and shear rate.

164. (C) It is a purely viscous Newtonian liquid
In dynamic oscillatory testing, the phase angle represents the relative balance of elastic and viscous properties. A phase angle of zero degrees indicates a perfectly elastic solid, where stress and strain are completely in phase. Conversely, a phase angle of ninety degrees signifies a purely viscous Newtonian liquid, where the stress and strain are entirely out of phase.

165. (A) It applies small stress increments to identify the onset of flow
Controlled stress rheometry is highly preferred for determining the yield stress of delicate dairy gels like yogurt. This methodology applies very small, progressive increments of shear stress while monitoring the resulting strain. This allows the precise identification of the exact stress threshold where the gel structure yields and begins to flow, without prematurely destroying the sample.

166. (D) The density difference between fat globules and continuous skim milk
According to Stokes' law, the velocity of gravity-driven creaming in a suspension is directly proportional to the density difference between the dispersed and continuous phases. In raw milk, the fat globules have a lower density than the surrounding skim milk serum. This buoyancy force drives the fat globules upward, leading to natural creaming during storage.

167. (B) It is ideal because the shear rate is uniform in the gap
Cone-and-plate rheometry is a highly precise geometry for testing low to medium viscosity fluids like milk. Its primary advantage is that the geometry angle compensates for the radial velocity gradient, ensuring that the shear rate remains completely uniform throughout the sample gap. This allows accurate calculation of shear stress and dynamic viscosity under controlled conditions.

168. (C) Chewiness
Texture Profile Analysis generates primary parameters that can be mathematically combined to calculate secondary textural characteristics. Chewiness is a secondary parameter specifically defined for solid foods. It is calculated by multiplying hardness, cohesiveness, and springiness. This derived value quantifies the energy required to masticate a solid dairy food, such as cheese, to a state ready for swallowing.

169. (D) It is an empirical test highly dependent on probe geometry, sample size, and test speed
A key limitation of Texture Profile Analysis is its highly empirical nature. The measured force values are not fundamental physical constants; instead, they depend heavily on the specific experimental conditions, such as probe geometry, sample dimensions, and compression speed. This dependency makes comparing results across different instruments and laboratories extremely difficult without strict standardization.

170. (A) I, III, IV and V
Capillary viscometers rely on pressure differences and dimensions, while orifice viscometers provide rapid, empirical measurements. Rotational viscometers are highly suitable for monitoring time-dependent viscosity changes. Falling sphere instruments require transparent samples to track the falling ball and are poorly suited for non-Newtonian fluids because the shear rate varies across the sphere surface. Therefore, statement two is incorrect.

171. (B) HPP disrupts casein micelles and denatures whey proteins, slightly raising viscosity without thermal damage
High-pressure processing alters milk rheology differently than heat treatments. The applied hydrostatic pressure physically disrupts the hydrophobic and electrostatic interactions

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jamming. This crowding causes the apparent viscosity of the cream to rise exponentially.

135. (A) Both A and R are true and R is the correct explanation of A.
The Einstein equation models the viscosity of dilute suspensions of rigid spheres. It assumes no hydrodynamic interactions, which is valid only below a volume fraction of five percent. Heavy cream contains approximately forty percent fat, representing a highly concentrated system where droplet interactions are dominant, rendering the simple Einstein model inadequate for predicting its viscosity.

136. (C) Fat globule coalescence at the surface into a solid layer
Cream plug formation is a defect in unhomogenized milk stored under static conditions. Due to density differences, large fat globules rise to the surface. As they crowd together at the top, their protective membranes rupture, causing the liquid fat to coalesce into a continuous, semi-solid, and impermeable layer. This results in an undesirable solid cream plug.

137. (D) Dilatancy – Shear-thickening behavior
Rheological behaviors are classified by how viscosity responds to shear rate or time. Dilatancy, also referred to as shear-thickening behavior, occurs when the apparent viscosity of a fluid increases with an increasing shear rate. This behavior is typically observed in highly concentrated suspensions where particles jam together under rapid flow conditions, restricting their movement.

138. (A) The toughness of the cheese
In large deformation testing, the mechanical behavior of cheese is evaluated up to its failure point. The total area under the stress-strain curve up to the point of fracture represents the work of fracture, which is a measure of toughness. This parameter quantifies the energy required to initiate and propagate a crack through the casein matrix.

139. (B) The ratio of intact to hydrolyzed casein
The structural matrix of processed cheese is governed by the state of its protein network. The ratio of intact to hydrolyzed casein determines the level of protein cross-linking and emulsifying capacity. A high proportion of intact casein provides elasticity and structural firmness, whereas hydrolyzed casein yields a softer, meltable texture, making this ratio critical for product performance.

140. (A) III, II, I, IV
Determining Power Law parameters begins by applying a range of rotational speeds to establish variable shear rates. Next, the corresponding shear stresses are measured using the instrument torque sensor. The collected data are then fitted to the linearized Power Law equation. Finally, the consistency index is determined from the intercept, and the flow behavior index is calculated from the slope.

141. (A) It mimics human chewing via two compression cycles
Texture Profile Analysis is a widely used instrumental method in dairy evaluation. Its chief advantage is its ability to mimic the physiological action of human chewing. By subjecting a food sample to two consecutive, controlled compression-relaxation cycles, the instrument extracts multiple primary and secondary textural parameters, such as hardness, cohesiveness, springiness, and chewiness, correlating well with sensory panels.

142. (C) Egg-box cross-linking of guluronic acid blocks by calcium ions
Sodium alginate forms strong, heat-stable gels through a specific ionic interaction mechanism. In the presence of divalent cations, particularly calcium ions abundant in dairy systems, the guluronic acid blocks of the alginate polymer chains align. This alignment permits the calcium ions to fit cooperatively between the chains, creating an egg-box structure that cross-links the polysaccharide network.

143. (D) Rotation destroys bubble structure, and wall slip confounds results
Measuring the rheology of highly aerated dairy foams using standard rotational rheometry is challenging. The continuous shear applied during rotational testing disrupts the delicate bubble network, altering the foam structure during measurement. Additionally, the formation of a low-viscosity liquid layer at the geometry walls causes wall slip, which confounds the data and yields inaccurate viscosity values.

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144. (C) The growth of large calcium lactate crystals at the expense of small ones in aged cheese
Ostwald ripening is the thermodynamic process where smaller crystals or droplets dissolve, and their material redeposits onto larger ones. In aged cheeses, this phenomenon drives the growth of large calcium lactate crystals on the surface or within curds at the expense of smaller, more soluble ones. This crystal growth significantly alters the visual appearance and sensory mouthfeel.

145. (B) The phase where the emulsifier is most soluble becomes the continuous phase
Bancroft's rule is a fundamental empirical guideline in emulsion science. It states that the phase in which an emulsifier is preferentially soluble will constitute the continuous phase of the final emulsion. Consequently, water-soluble emulsifiers promote the formation of oil-in-water emulsions, whereas oil-soluble emulsifiers favor the development of water-in-oil systems, directing structural stability during formulation.

146. (D) The extent to which a deformed sample recovers its original height before the second compression
Springiness is a key textural parameter determined through Texture Profile Analysis. It quantifies the physical capacity of a food sample to recover its original height after being deformed during the first compression cycle. This recovery is measured during the time interval between the end of the first decompression and the start of the second mechanical compression stroke.

147. (A) At very high shear rates where alignment is maximized
A pseudoplastic dairy fluid exhibits shear-thinning behavior, where its apparent viscosity decreases as the shear rate increases. At extremely high shear rates, the dispersed particles or polymer chains become maximally aligned and streamlined along the flow lines, minimizing structural resistance. Consequently, the viscosity asymptotically approaches a constant, minimum value known as the high-shear limiting viscosity.

148. (C) Cryo-Scanning Electron Microscopy (Cryo-SEM)
Observing fat crystals in ice cream requires maintaining sub-zero temperatures to prevent melting. Cryo-scanning electron microscopy is highly suitable for this application. The sample is rapidly frozen, fractured, and imaged under high vacuum at cryogenic temperatures. This process preserves the delicate matrix of fat crystals, ice crystals, and air bubbles, allowing high-resolution microstructural observation.

149. (A) It requires three parameters, making curve fitting more complex than two-parameter models
The Herschel-Bulkley model is widely used to describe non-Newtonian dairy fluids that possess a yield stress. A specific disadvantage of this model is its mathematical complexity, as it requires three fitting parameters: yield stress, consistency index, and flow behavior index. This extra parameter makes mathematical curve fitting more complex than simpler two-parameter models like the Power Law.

150. (A) I and II
Butter is a water-in-oil emulsion containing dispersed aqueous droplets within a continuous fat phase. It exhibits a distinct yield stress, meaning it behaves like an elastic solid and resists flow until a critical mechanical force is applied. However, at refrigeration temperatures, its continuous fat phase consists of a complex network of solid fat crystals, not entirely liquid oil.

151. (B) The oriented, fibrous network of cross-linked casein
The characteristic chewiness and stretchability of Mozzarella cheese on a pizza are driven by its microstructure. During the stretching step of manufacture, the para-casein matrix is aligned into oriented, parallel fibrous strands. This highly structured protein network provides mechanical elasticity and resistance to deformation when heated, yielding the desirable chewy texture during eating.

152. (C) Stirred yogurt thins and becomes more liquid-like during mixing or chewing
Yogurt is a thixotropic material, meaning its structure undergoes time-dependent breakdown under shear. When a consumer stirs or chews yogurt, the applied mechanical force breaks the weak electrostatic and hydrophobic bonds holding the casein network together. This structural disruption causes the product to thin and become more liquid-like, directly influencing oral perception and swallowability.

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153. (D) It drives gas diffusion from small to large bubbles due to pressure differences
Laplace pressure is inversely proportional to bubble radius, meaning smaller bubbles in a dairy foam experience higher internal pressure than larger ones. This pressure gradient drives the diffusion of gas from small bubbles into the surrounding serum phase and eventually into larger bubbles. This process, known as disproportionation, leads to foam coarsening and eventual destabilization.

154. (A) Formation of a strong gel structure not formed by either alone
Blending locust bean gum and xanthan gum in a dairy formulation produces a highly functional synergistic effect. While neither polysaccharide forms a gel individually under typical conditions, their combination results in strong gelation. This occurs because the ordered segments of xanthan gum associate directly with the unsubstituted mannose regions of locust bean gum, creating a stable three-dimensional junction network.

155. (B) Arrhenius equation
The temperature dependence of viscosity in liquid dairy products is mathematically modeled using the Arrhenius equation. This relationship states that viscosity decreases exponentially as temperature increases, as thermal energy overcomes the intermolecular activation energy barriers of flow. This model is critical for designing thermal processing equipment and estimating pumping requirements in dairy processing plants.

156. (B) Controlled rate sets shear rate and measures stress, while controlled stress sets force and measures strain
The fundamental difference between controlled rate and controlled stress rheometers lies in the controlled variable. Controlled rate instruments apply a predefined shear rate (rotational speed) and measure the resulting shear stress. Conversely, controlled stress rheometers apply a specified torque (force) to the sample and measure the resulting deformation strain, which is highly useful for characterizing yield stress.

157. (B) P-3, Q-2, R-1
Oral tribology describes three primary lubrication regimes. Boundary lubrication is dominated by direct surface-to-surface contact where thin boundary molecular layers determine friction. Mixed lubrication involves support from both the fluid film and surface contacts. Hydrodynamic lubrication occurs at higher sliding speeds, where a thick continuous fluid film fully supports the load, making bulk viscosity the dominant physical factor.

158. (C) Correlating soft-tribology friction coefficients with creaminess or roughness perception
Tribology is applied in dairy science to evaluate oral tactile sensations that cannot be predicted by rheology alone. By measuring the friction coefficient of a dairy product using soft, biomimetic surfaces, researchers can simulate tongue-palate interactions. These soft-tribology measurements correlate strongly with sensory attributes like creaminess, smoothness, fat mouthfeel, and the perception of oral roughness.

159. (D) Viscosity decreases
Non-Newtonian, shear-thinning dairy fluids contain structured macromolecular networks or aggregated particles. When the rotational speed of a coaxial cylinder viscometer is increased, the shear rate rises. This mechanical energy aligns the polymers in the flow direction and disrupts weak intermolecular associations. Consequently, flow resistance is reduced, and the apparent viscosity of the dairy fluid decreases.

160. (A) II and IV
Homogenization prevents creaming by drastically reducing the size of fat globules, not by altering their density. Flocculation is a reversible process where droplets aggregate into clusters while maintaining their individual interfaces, whereas coalescence involves droplets merging into a single larger droplet. Therefore, the assertions regarding homogenization mechanisms and the definition of flocculation are physically incorrect.

161. (B) Rennet gels undergo para-casein network contraction, actively expelling whey
Rennet-coagulated gels are highly susceptible to syneresis due to their active structural dynamics. The enzymatic cleavage of kappa-casein by rennet leaves hydrophobic para-casein micelles that aggregate. This hydrophobic network undergoes spontaneous structural contraction over time, actively squeezing out the entrapped serum. In contrast, acid gels are stabilized by electrostatic interactions at pH four point six, resisting contraction.

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the phase in which the emulsifier is most soluble becomes the continuous phase of the emulsion. Consequently, these lipophilic surfactants promote water-in-oil systems like butter, where water droplets are dispersed within a continuous oil matrix.

181. (A) Dynamic Shear Rheometer
Viscoelastic properties, specifically the storage modulus and loss modulus, quantify the elastic and viscous behavior of dairy gels. A dynamic shear rheometer is the primary instrument used to measure these parameters. By applying small-amplitude oscillatory shear within the linear viscoelastic region, this instrument characterizes the structural network of gels without inducing destructive physical breakdown.

182. (D) Partial coalescence forms irregular fat clumps; complete coalescence merges droplets fully
Partial coalescence occurs when semi-crystalline fat globules collide, and internal fat crystals pierce the interfacial film, forming irregular, solid-like fat clumps that retain individual droplet identities. In contrast, complete coalescence involves the total merging of liquid fat droplets into a single, larger spherical droplet, destroying the original interfaces. This structural distinction is critical for ice cream stabilization.

183. (B) It shifts flow from Newtonian to shear-thinning, eventually inducing a yield stress
Increasing the dispersed phase volume fraction of an emulsion alters its rheological behavior. At low concentrations, the emulsion behaves as a Newtonian fluid. As droplet packing increases, hydrodynamic interactions and crowding restrict droplet movement. This transition shifts the flow behavior to shear-thinning and eventually induces a distinct yield stress once a close-packed structural network forms.

184. (C) Viscosity gradually increases over time as structure rebuilds
Thixotropy is defined as a time-dependent decrease in viscosity under constant shear, followed by a gradual structural recovery when the shear is removed or reduced. When the shear rate applied to a thixotropic yogurt is stepped down, the reduced mechanical disruption allows the casein network to slowly rebuild, causing the apparent viscosity to increase gradually over time.

185. (D) Milk proteins (Caseins and Whey proteins)
Milk proteins possess amphiphilic molecular structures containing both hydrophobic and hydrophilic regions. This chemical nature allows them to migrate rapidly to air-water and oil-water interfaces during processing. Once adsorbed, they lower interfacial tension and form a cohesive viscoelastic protective film, making caseins and whey proteins the primary components responsible for the natural emulsifying and foaming properties of milk.

186. (A) Small, recoverable elastic deformation
Creaming stability in oil-in-water dairy emulsions is governed by Stokes' law. To minimize the rate of gravitational separation, the formulation should possess a small average fat droplet size and a highly viscous continuous phase. Reducing droplet diameter decreases buoyancy forces, while increasing the serum viscosity slows droplet movement, ensuring long-term physical stability against phase separation.

187. (B) The ratio of G'' to G'
In dynamic rheological testing, the loss tangent is a dimensionless parameter that quantifies the relative dominance of viscous to elastic behavior in a viscoelastic material. It is calculated as the mathematical ratio of the viscous loss modulus to the elastic storage modulus. A value less than one indicates dominant elastic, solid-like structural behavior.

188. (B) The continuous para-casein network
The mechanical strength and structural integrity of Cheddar cheese curds are provided by their continuous para-casein network. During coagulation, chymosin cleaves glycomacropeptides from kappa-casein, initiating the aggregation of hydrophobic para-casein micelles. This aggregation forms a robust, three-dimensional protein network that entraps fat globules and moisture, determining the overall firmness and elasticity of the curd.

189. (A) It determines if a product pours under its own weight or requires squeezing
Measuring yield stress is highly relevant for consumer handling and product functionality. It determines whether a semi-solid dairy product, such as sour cream or custard, will flow under its own weight or require external squeezing to dispense. This parameter directly dictates consumer perceptions of spoonability,

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stabilizing casein micelles, breaking them into smaller sub-micelles. Concurrently, it denatures whey proteins, which then associate with the caseins. This structural restructuring increases water-binding capacity, slightly raising milk viscosity without inducing heat-related chemical damage.

172. (B) Electrostatic binding between carrageenan sulfates and positive kappa-casein regions
The synergistic gelation of kappa-carrageenan and casein micelles is driven by electrostatic interactions. At the native pH of milk, casein micelles carry a net negative charge, but they possess a highly localized positive patch on kappa-casein. The negatively charged sulfate groups of the carrageenan polymer bind to these positive patches, forming a stable, interconnected protein-polysaccharide network.

173. (A) Apparent is from steady shear, while complex is from oscillatory testing
Apparent viscosity and complex viscosity are determined using different rheological methodologies. Apparent viscosity is calculated from steady-state rotational shear measurements, representing resistance under continuous flow. In contrast, complex viscosity is derived from dynamic oscillatory testing under small-strain conditions. This dynamic measurement captures both the elastic storage and viscous loss responses of a viscoelastic material simultaneously.

174. (C) Adding a highly insoluble oil to the dispersed phase to eliminate the concentration gradient
Ostwald ripening is driven by the concentration gradient of dissolved oil between small and large droplets. Adding a highly water-insoluble oil to the dispersed phase creates an entropy-driven barrier. As smaller droplets begin to dissolve, the concentration of the insoluble component increases within them, generating an osmotic pressure that opposes and eventually halts the mass transfer process.

175. (D) It forms a thick, hydrated polymer layer around the droplet that prevents coalescence
Sodium caseinate is a high-molecular-weight protein that acts as an effective steric stabilizer. Upon adsorption at the oil-water interface, the hydrophilic segments of the protein extend into the continuous aqueous phase, forming a thick, highly hydrated polymer brush layer. This physical barrier prevents droplets from approaching close enough to undergo attractive interactions, effectively preventing coalescence.

176. (C) A concentrated oil-in-water emulsion showing pseudoplastic behavior due to crowding
Mayonnaise is classified as a concentrated oil-in-water emulsion. It contains a high volume fraction of dispersed oil droplets stabilized by egg yolk proteins. Because the droplets are highly crowded and tightly packed, they exhibit intense physical interactions under flow. This structural crowding yields a distinct yield stress and pronounced pseudoplastic, shear-thinning rheological behavior during processing and consumption.

177. (B) Casson equation
Purely Newtonian fluids like water exhibit a constant viscosity that is completely independent of the applied shear rate. The Casson model is a viscoplastic model designed specifically for fluids that possess a distinct yield stress. Because water has zero yield stress and does not shear-thin, applying this complex model would be highly mathematically inappropriate and unnecessary.

178. (D) The number and strength of bonds forming the continuous three-dimensional network
On a microscopic level, the yield stress of a dairy gel is dictated by the structural integrity of its network. It represents the minimum mechanical force required to break the colloidal junctions holding the matrix together. This threshold is determined by the number, density, and physical strength of the chemical and physical bonds forming the continuous three-dimensional network.

179. (A) Due to viscous drag and internal friction of the fluid film opposing motion
Within the hydrodynamic lubrication regime, the sliding surfaces are completely separated by a continuous fluid lubricant film. As the sliding speed increases to high levels, the shear rate within the liquid film rises proportionately. This rapid movement generates significant viscous drag and internal friction within the fluid bulk, causing the overall friction coefficient to rise.

180. (A) Both A and R are true and R is the correct explanation of A.
Emulsifiers with low HLB values are highly lipophilic, making them preferentially soluble in the oil phase. According to Bancroft's rule,

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leading to structural jamming. This temporary packing restriction increases flow resistance and raises the apparent viscosity of the fluid.

126. (C) Measuring gravity-driven efflux time of a set volume through a bottom orifice
Orifice viscometers operate on the principle of gravity-driven flow through a calibrated opening. The time required for a specified volume of fluid to flow completely out of the container through the bottom orifice is measured. This efflux time is directly related to the kinematic viscosity of the liquid, providing a rapid method for quality control.

127. (D) The changing head causes shear rate variation, preventing absolute calculations
Orifice viscometers are empirical tools because the driving force is gravity, which decreases continuously as the fluid level drops during empty. This declining hydrostatic head causes the shear rate within the orifice to vary throughout the measurement. Consequently, the instrument cannot define a single constant shear rate, preventing the calculation of fundamental, absolute rheological values.

128. (C) Friction coefficient versus a multi-variable entrainment parameter
In tribology, the Stribeck curve is a classical tool used to map lubrication behavior across different regimes. It plots the friction coefficient against a dimensionless entrainment parameter, which incorporates sliding speed, dynamic viscosity, and contact load. This relationship helps identify transitions between boundary, mixed, and hydrodynamic lubrication states during oral processing of food systems.

129. (B) Fat acts as a filler disrupting the casein network; its removal yields a denser protein matrix
In full-fat cheeses, fat globules act as inert fillers that physically interrupt the continuous three-dimensional casein network, creating a softer texture. When fat is removed to make low-fat cheese, the protein matrix becomes highly concentrated and densely cross-linked. This structural density increases resistance to deformation, resulting in a firmer, rubbery texture.

130. (A) II, III, I
During the oral processing of a dairy drink, sliding speed between oral surfaces increases progressively. At very low speeds, surface contacts dominate, representing boundary lubrication. As speed rises, liquid enters the contact zone, entering mixed lubrication. At high speeds, a continuous fluid film completely separates the surfaces, achieving hydrodynamic lubrication. Thus, the chronological transition sequence is boundary, mixed, then hydrodynamic.

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131. (A) Kappa-carrageenan
Kappa-carrageenan is a sulfated galactan extracted from red seaweed that functions as a structural stabilizer. Upon heating, its polymer chains form random coils. Cooling induces a conformational transition into double helices, which aggregate into a rigid three-dimensional network that traps water. This gelation process is thermally reversible, melting upon heating and reforming when cooled.

132. (C) To identify the linear viscoelastic region (LVR) of the gel
A strain sweep in dynamic oscillatory rheometry is performed by applying increasing strain amplitudes at a constant frequency. The primary purpose is to determine the linear viscoelastic region of the dairy gel. Within this region, the storage and loss moduli remain independent of strain, ensuring that subsequent dynamic measurements do not damage the gel structure.

133. (A) Foam stability
Foam stability refers to the capability of an aerated dairy system to maintain its volume and resist phase separation over time. This property depends on the structural resistance of the bubble interfaces against liquid drainage, bubble coalescence, and gas disproportionation. Highly stable foams prevent these destabilization processes, preserving the light, aerated texture during storage.

134. (D) Apparent viscosity rises exponentially near maximum packing
Increasing the volume fraction of dispersed fat droplets restricts the free movement of the continuous serum phase. At low concentrations, viscosity increases moderately. However, as the volume fraction approaches maximum packing, the droplets become tightly crowded, leading to intense hydrodynamic interactions and structural

spreadability, and shape retention during storage and serving.

190. (A) P-2, Q-3, R-4, S-1
Texture Profile Analysis parameters are defined by specific load-deformation curve features. Hardness is the peak force of the first compression. Adhesiveness is represented by the negative force area during probe withdrawal. Cohesiveness is calculated as the ratio of the positive force area of the second compression to the first, and springiness is the recovery distance between cycles.

191. (C) Irreversible network formation yielding a pudding-like consistency
Age gelation is a structural defect occurring in UHT-sterilized milk during extended storage. It is characterized by a sudden, massive increase in viscosity, leading to irreversible network formation that yields a pudding-like consistency. This defect is primarily driven by enzymatic proteolysis of caseins by residual heat-stable bacterial proteases or chemical modifications involving whey protein-casein complexes.

192. (C) An intact casein network with distinct gas eyes
The characteristic elasticity of Swiss cheese is attributed to its highly structured macromolecular network. An intact, well-developed para-casein protein matrix provides the necessary tensile strength to deform without fracturing. This elastic network allows the cheese to accommodate the localized pressure of carbon dioxide gas produced by propionic acid bacteria, forming distinct, smooth round eyes.

193. (B) The Krieger-Dougherty equation
The Krieger-Dougherty equation is a semi-empirical model used to describe the viscosity of concentrated suspensions. Unlike the Einstein model, which is limited to dilute systems, this equation incorporates the maximum packing fraction and the self-crowding effect of particles. This makes it highly suited for modeling highly concentrated dairy suspensions where particle-particle interactions dominate flow behavior.

194. (D) The emulsifier must be highly water-soluble
Formulating a dairy-based coffee creamer, which is an oil-in-water emulsion, requires a stable continuous aqueous phase. According to Bancroft's rule, the phase in which the emulsifying agent is most soluble becomes the continuous phase of the system. Therefore, to ensure that water remains the continuous phase, the chosen surfactant emulsifier must be highly water-soluble.

195. (A) Small, recoverable elastic deformation
In dynamic rheology, the linear viscoelastic region represents the strain range where the material structure remains undamaged. Within this region, any applied deformation is small and completely recoverable, meaning the gel behaves like an ideal elastic solid. This non-destructive testing allows researchers to measure the fundamental elastic storage modulus without causing permanent structural fracture.

196. (C) Shear-induced jamming of particles, increasing flow resistance
Shear-thickening in concentrated whey protein dispersions is driven by a microstructural transition under flow. At high shear rates, the close-packed protein particles cannot slide past one another fast enough to maintain laminar flow. This leads to shear-induced jamming and hydrodynamic clustering of the particles, which increases resistance to flow and causes a sharp rise in viscosity.

197. (C) A is true but R is false.
High-pressure homogenization slightly increases milk viscosity because it breaks fat globules into smaller droplets, increasing the total surface area and the amount of adsorbed casein. However, the reason is false because homogenization does not cause these droplets to fuse into a solid, rigid fat matrix; instead, they remain individually dispersed and stabilized by proteins.

198. (D) A weak gel has a G' dependent on frequency and breaks at lower strain
In dynamic rheological testing, weak gels are distinguished from strong gels by their response to frequency and strain. Weak gels, such as stirred yogurt, possess a storage modulus that exhibits significant frequency dependence and undergo structural breakdown at low strain levels. Strong gels show a highly stable storage modulus independent of frequency, resisting larger strains before fracturing.

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to its concentrated composition. The high concentration of dissolved sugars and suspended milk solids creates complex intermolecular entanglements under static conditions. Applying shear aligns these proteins and sugars along the flow lines, reducing resistance and causing a corresponding decrease in apparent viscosity as the shear rate increases.

218. (A) The negative force area is highly dependent on probe speed and surface material
A key limitation of using the Texture Profile Analysis parameter of adhesiveness is its sensitivity to experimental conditions. Adhesiveness is calculated as the negative force area during the upward withdrawal of the probe. This value is highly dependent on non-intrinsic variables, including probe withdrawal speed, surface roughness, and chemistry, making it difficult to obtain fundamental material values.

219. (B) Its high yield stress, allowing it to hold shape on the spoon
The spoonability of set yogurt is governed by its viscoplastic nature. Set yogurt possesses a distinct yield stress, which is the minimum stress required to initiate flow. Below this threshold, the gel behaves like an elastic solid. This yield stress allows the yogurt to support its own weight and hold its shape on a spoon during consumption, resisting gravity.

220. (B) Multiple emulsion
Multiple emulsions are complex polydisperse systems where the dispersed droplets contain even smaller droplets of a different phase. A water-in-oil-in-water system is a classic multiple emulsion, consisting of water droplets dispersed inside larger oil droplets, which are themselves suspended in a continuous aqueous phase. These systems are highly useful for encapsulating sensitive nutrients in dairy formulations.

221. (A) It fits both yield stress and shear-thinning of molten chocolate better than the Bingham model
The Casson equation is highly preferred for modeling molten chocolate in dairy-confectionery applications. Unlike the simple linear Bingham model, the Casson model effectively accounts for both the initial yield stress and the non-linear, shear-thinning behavior at higher shear rates. This provides a more accurate fit to the experimental flow data, which is critical for optimization of pumping.

222. (C) The elastic storage modulus (G') vastly exceeds the loss modulus (G')
The phase angle is a direct measure of the viscoelastic nature of a material. A phase angle close to zero degrees indicates a highly structured, solid-like material. In this state, the elastic storage modulus vastly exceeds the viscous loss modulus, meaning the material stores almost all applied deformation energy elastically, representing a highly robust, interconnected dairy gel.

223. (D) Aggregation and cross-linking of destabilized casein micelles into a network that entraps water
During the acidification of milk, the transition from a liquid sol to a solid gel occurs as the pH approaches the isoelectric point of casein. The reduction in electrostatic repulsion causes the destabilized casein micelles to aggregate. These aggregating proteins cross-link into a continuous three-dimensional network that physically entraps the continuous serum phase, completing the gelation process.

224. (C) Larger fully hydrated polymer volume restricts water mobility more, raising bulk viscosity
The thickening power of dairy stabilizers is directly related to their hydrodynamic volume in solution. When a polysaccharide like guar gum hydrates, it expands into a large macromolecular conformation. This large hydrodynamic volume restricts the physical movement of water molecules and increases friction between polymer chains, which significantly raises the apparent bulk viscosity of the dairy system.

225. (A) P-4, Q-1, R-3, S-2
Tribological parameters correlate with specific oral tactile sensations. High boundary friction indicates surface roughness or chalkiness. Very low friction in the mixed regime predicts creaminess and smoothness. A thick hydrodynamic lubricant film correlates with bulk thickness and mouth-coating, while the depletion of the protective salivary film predicts astringency, showing how tribology predicts diverse sensory attributes.

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shear rate, where sigma represents the shear stress, sigma zero is the yield stress, eta p is the plastic viscosity, and gamma dot is the shear rate. The material flows linearly only after the yield stress is exceeded.

209. (B) A measure of fluid viscosity at a shear rate of 1 s^{-1}
In the Power Law model, the consistency index is a fundamental parameter that quantifies the flow resistance of a fluid. Mathematically, it represents the apparent viscosity of the material at a shear rate of exactly one reciprocal second. A higher value indicates a more viscous fluid, providing a comparative measure of bulk thickness under standardized conditions.

210. (D) Laplace pressure differences between different-sized bubbles
Ostwald ripening in dairy foams is driven by Laplace pressure differences. Because Laplace pressure is inversely proportional to bubble radius, smaller bubbles experience higher pressure than larger ones. This pressure gradient causes gas to dissolve from smaller bubbles, diffuse through the continuous liquid serum phase, and redeposit into larger bubbles, leading to a coarser, less stable foam structure over time.

211. (A) By reducing fat globule diameter, slowing creaming per Stokes' Law
Homogenization prevents the creaming of milk fat by passing milk through a high-pressure valve, which breaks large fat globules into much smaller droplets. According to Stokes' Law, the velocity of gravitational creaming is proportional to the square of the droplet radius. Reducing this radius drastically decreases the rising velocity, effectively stabilizing the emulsion against phase separation.

212. (A) P-2, Q-3, R-4, S-1
Texture Profile Analysis parameters are calculated from force-time curves. Gumminess is the product of hardness and cohesiveness, applicable to semi-solids. Chewiness is calculated by multiplying gumminess by springiness, used for solid foods. Resilience is the ratio of recoverable energy to total energy during the first compression, and hardness is the peak force of the first compression stroke.

213. (A) Proteins form a cohesive, viscoelastic interfacial film that resists disruption
Milk proteins stabilize dairy foams more effectively than low-molecular-weight surfactants. Upon adsorbing at the air-water interface, proteins unfold and cross-link via hydrophobic and electrostatic interactions, forming a highly cohesive, viscoelastic macromolecular film. This elastic membrane resists deformation and prevents bubble rupture, whereas surfactant-stabilized films are highly mobile and lack the mechanical strength to resist long-term drainage.

214. (D) Average droplet size increases via coalescence and Ostwald ripening
Coarsening is a major physical destabilization pathway in dairy emulsions and foams. During this phase, the average size of the dispersed droplets or bubbles increases over time. This growth occurs through two primary mechanisms: coalescence, where colliding droplets merge, and Ostwald ripening, where mass transport drives material from smaller to larger droplets, reducing overall interfacial area.

215. (B) Binding between smooth galactomannan regions and carrageenan double helices
The synergistic gelation between locust bean gum and kappa-carrageenan is driven by a specific intermolecular binding mechanism. Kappa-carrageenan forms double helices upon cooling. The unsubstituted, smooth galactomannan regions of the locust bean gum associate directly with these carrageenan double helices. This physical association forms an ordered, cross-linked junction network that significantly enhances gel strength and water-binding capacity.

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216. (C) It has a low fracture strain, snapping with little structural yielding
In large deformation mechanics, the brittleness of a cheese is characterized by its failure behavior under stress. A highly brittle cheese has a very low fracture strain. When subjected to compression, it cannot deform significantly and snaps or fractures with little to no prior plastic yielding, indicating a rigid, highly cross-linked, and inflexible internal protein network.

217. (A) Both A and R are true and R is the correct explanation of A.
Sweetened condensed milk exhibits non-Newtonian, shear-thinning behavior due

(C) Lactobacillus helveticus or other lactobacilli
(D) Aspergillus niger or Kluyveromyces lactis

2007

33. What is the fundamental advantage of utilizing recombinant chymosin over natural microbial coagulants in the production of long-ripened hard cheeses?
(A) It exhibits highly specific cleavage of kappa-casein with minimal non-specific proteolysis, preventing bitterness.
(B) It survives commercial pasteurization temperatures, which enables continuous, indefinite cheese ripening.
(C) It actively ferments residual lactose in the curd, completely eliminating the need for starter cultures.
(D) It accelerates early-stage lactic acid glycolysis during the first twenty-four hours of curd pressing.

2014

34. Which biochemical bond in the casein micelle is specifically cleaved by chymosin during the primary phase of milk coagulation?
(A) The peptide bond between Leucine (192) and Tyrosine (193) in alpha-s1-casein
(B) The disulfide bond bridging beta-lactoglobulin and kappa-casein residues
(C) The peptide bond between Phenylalanine (105) and Methionine (106) in kappa-casein
(D) The ester phosphate bond linking calcium phosphate to beta-casein fractions

2003

35. Consider the following statements concerning milk-clotting enzymes:
I. Pepsin is more sensitive to pH variations during milk clotting than chymosin.
II. Extract of Cynara cardunculus is a plant-based coagulant used for certain traditional cheeses.
III. Microbial coagulants have generally lower thermal stability than bovine chymosin.
IV. Recombinant chymosin is chemically identical to natural bovine chymosin.
Which of the above statements are correct?
(A) I, II and III
(B) I, II and IV
(C) II, III and IV
(D) I, III and IV

2015

36. Which physical phenomenon characterizes the secondary (non-enzymatic) phase of rennet coagulation?
(A) The enzymatic cleavage of kappa-casein into para-kappa-casein and glycomacropeptide by active coagulants.
(B) The rapid drop in bulk milk pH occurring through the biochemical action of chymosin on residual lactose.
(C) The thermal precipitation of denatured whey proteins directly onto the hydrophilic casein micelle surface.
(D) The aggregation of para-casein micelles mediated by calcium ions and hydrophobic bonds above 20°C.

2024

37. How does acid-induced gelation fundamentally differ from rennet-induced coagulation?
(A) Acid gelation requires high heat to initiate, whereas renneting occurs efficiently at refrigeration temperatures.
(B) Acid gelation occurs via colloidal calcium phosphate solubilization and charge reduction as pH drops to 4.6.
(C) Acid gelation is driven by enzymatic cleavage of casein, whereas renneting relies on isoelectric precipitation.
(D) Acid gelation produces a highly elastic, rubbery curd structure that expels whey rapidly, unlike rennet curd.

2015

38. During the primary phase of rennet coagulation, the release of the macropeptide (glycomacropeptide) into the whey directly results in which of the following?
(A) A significant increase in both the net negative charge and hydration of the casein micelle
(B) The immediate heat-induced denaturation and precipitation of alpha-lactalbumin fractions
(C) A drastic reduction in the steric repulsion and electronegativity of the casein micelles
(D) The rapid chemical conversion of soluble calcium ions into insoluble colloidal calcium phosphate

2006

39. Which condition is most relevant for inhibiting the secondary phase of rennet coagulation while allowing the primary phase to proceed?
(A) Increasing the concentration of soluble

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226. (D) Shear-induced structural buildup over time, raising apparent viscosity
Rheopexy is a rare, time-dependent rheological behavior observed in some specialized suspensions. It is defined as a shear-induced structural buildup over time under a constant shear rate, which causes the apparent viscosity of the fluid to increase. This behavior is the exact opposite of thixotropy, where shear causes structural breakdown and viscosity reduction over time.

227. (A) Both A and R are true and R is the correct explanation of A.
Scanning electron microscopy requires high vacuum conditions during operation. For high-moisture dairy gels, this vacuum would cause rapid water evaporation, leading to severe structural collapse and preparation artifacts. Therefore, sample preparation must involve critical point drying or freeze-drying to properly remove or immobilize the water phase while preserving the delicate three-dimensional protein network structure.

228. (C) Its solubility phase dictating the emulsion's continuous phase
Bancroft's rule strictly defines the relationship between the solubility of an emulsifier and the resulting emulsion type. The rule states that the phase in which the emulsifier exhibits the highest solubility will become the continuous phase of the system. Thus, a water-soluble surfactant dictates an oil-in-water system, whereas an oil-soluble surfactant dictates a water-in-oil system.

229. (A) Its apparent viscosity increases as the applied shear rate increases
A dilatant fluid, also known as a shear-thickening fluid, is characterized by its viscosity behavior under shear. Its apparent viscosity increases as the applied shear rate increases. This behavior typically occurs in highly concentrated suspensions, where rapid shear forces cause particles to expand or jam together, increasing flow resistance and bulk viscosity during processing.

230. (D) To leverage synergistic gum gelation for texture and the emulsifier for smooth meltdown
Formulating a complex dairy dessert often requires a combination of stabilizing and emulsifying agents. Combining kappa-carrageenan and locust bean gum leverages their synergistic gelation, creating a robust, water-binding gel network that provides a desirable custard-like texture. Concurrently, adding mono- and diglycerides controls fat crystallization and partial coalescence, ensuring a highly smooth, controlled meltdown during consumption.

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CHAPTER 07

Cheese and Fermented Milk Products & Biotechnological Application in Dairy Processing

2025

1. Which of the following is the defining criterion for classifying a cheese as a "hard" cheese based on moisture on a fat-free basis (MFFB)?
(A) Moisture on a fat-free basis (MFFB) less than 49%
(B) Moisture on a fat-free basis (MFFB) between 49% and 56%
(C) Moisture on a fat-free basis (MFFB) between 54% and 69%
(D) Moisture on a fat-free basis (MFFB) between 67% and 73%

2018

2. Under FSSAI regulations, what is the mandatory minimum milk fat content on a dry matter basis required for standard Cheddar cheese?
(A) 30 percent
(B) 40 percent
(C) 48 percent
(D) 55 percent

2003

3. Which of the following best describes the fundamental principle used to classify cheese varieties into extra-hard, hard, semi-hard, and soft categories?
(A) The percentage of moisture calculated on a fat-free basis
(B) The concentration of lactic acid bacteria present post-ripening
(C) The ratio of casein to whey proteins in the final matrix
(D) The duration and temperature of the ripening period

2011

4. In the standard classification of cheese based on ripening methods, how is Roquefort primarily categorized?
(A) Surface-ripened with bacteria
(B) Unripened soft cheese
(C) Surface mold-ripened
(D) Internally mold-ripened

2013

5. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): Cheese manufactured using animal-derived rennet is classified as non-vegetarian under Indian labeling regulations.
Reason (R): Animal rennet is obtained from the abomasum of slaughtered young calves, making the final product of animal origin.
Based on these statements, choose the correct option:
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2009

6. Which of the following is an INCORRECT statement regarding the classification of cheese by fat content?
(A) High-fat cheese has a fat on dry basis (FDB) of greater than 60%.
(B) Full-fat cheese typically requires an FDB between 45% and 60%.
(C) Medium-fat cheese requires an FDB of strictly less than 10%.
(D) Skim milk cheese is categorized when FDB is generally below 10%.

2017

7. What is the primary functional health attribute of the conjugated linoleic acid (CLA) found in high-fat ripened cheeses?
(A) Promotion of intense rapid gastric emptying
(B) Inhibition of whey protein denaturation during cooking

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(C) Enhancement of lactose crystallization in the gut
(D) Potential anticarcinogenic and anti-atherogenic effects

2004
8. Which of the following therapeutic benefits is most directly associated with the consumption of long-ripened hard cheeses like Parmesan?
(A) Supplying bioactive peptides with antihypertensive properties
(B) Delivering a high load of active probiotic lactobacilli to the colon
(C) Providing a rich source of dietary fiber for bowel regulation
(D) Supplying unhydrolyzed lactose for colonic fermentation

2006
9. Why are mature hard cheeses generally considered safe for lactose-intolerant individuals?
(A) The milk undergoes extensive thermal lactose degradation during the pasteurization process.
(B) Most lactose is lost in the whey, and the residual lactose is fermented into lactic acid.
(C) Propionibacteria actively convert lactose into conjugated linoleic acid during the aging phase.
(D) Exogenous beta-galactosidase is mandatorily added to the milk prior to curd coagulation.

2019
10. Which statement INCORRECTLY pairs a fermented dairy product with its primary nutritional advantage?
(A) Yoghurt: Enhanced calcium bioavailability due to low pH
(B) Cheddar cheese: Excellent source of water-soluble vitamin C
(C) Kefir: Provision of both lactic acid bacteria and beneficial yeasts
(D) Cottage cheese: High-quality, intact casein-dominant protein source

2018
11. What is the primary consequence of high somatic cell counts (SCC) in raw milk destined for cheese manufacture?
(A) Reduced cheese yield and elevated levels of endogenous proteases like plasmin
(B) Enhanced curd firmness, reduced syneresis, and shorter overall coagulation time
(C) Increased total yield due to structural retention of somatic cell membranes
(D) Improved sensory profiles from enhanced lipolysis by leukocyte esterases

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2023
12. Which of the following factors most critically impairs the primary (enzymatic) phase of rennet coagulation?
(A) Mild acidification of cheese milk to pH 6.0
(B) Solubilization of colloidal calcium phosphate during cold storage
(C) Heat-induced association of beta-lactoglobulin with kappa-casein
(D) Addition of trace amounts of calcium chloride (0.02%)

2011
13. Which specific defect in raw milk is most likely to cause "early blowing" in cheese?
(A) High somatic cell count exceeding 500,000 cells/ml
(B) Presence of Clostridium tyrobutyricum spores
(C) Elevated levels of free fatty acids from lipolysis
(D) Contamination with coliforms and Enterobacter aerogenes

2002
14. Which statement represents a correct concept regarding the microbiological prerequisites of milk for cheese making?
(A) Psychrotrophic bacteria in chilled raw milk are completely harmless because they are fully destroyed during pasteurization.
(B) Thermoduric bacteria surviving standard pasteurization are primarily responsible for the late blowing defect in hard cheeses.
(C) Heat-stable enzymes produced by psychrotrophs cause flavor and texture defects even after milk pasteurization.
(D) Lactic acid bacteria naturally present in raw milk must be fully eliminated in order for starter cultures to function.

2006
15. Match the raw milk quality parameters in List I with their primary impact on cheese making in List II:
List I: (Raw Milk Quality Parameter)
P. High psychrotroph count
Q. High coliform count
R. Spores of Clostridium tyrobutyricum
S. Mastitic milk (High SCC)
List II: (Primary Impact)
1. Late blowing defect

2. Poor curd firming and lower yield
3. Early gas production and off-flavors
4. Post-pasteurization enzymatic degradation

(A) P-4, Q-3, R-1, S-2
(B) P-3, Q-4, R-2, S-1
(C) P-4, Q-1, R-3, S-2
(D) P-2, Q-3, R-1, S-4

2017

16. What is the primary purpose of adjusting the casein-to-fat ($\frac{C}{F}$) ratio during milk standardization for cheese making?
(A) To ensure that the finished cheese meets legal moisture standards
(B) To accelerate the replication rate of mesophilic starter cultures
(C) To completely inactivate all indigenous lipases in the milk supply
(D) To regulate the final fat-in-dry-matter content of the cheese

2002

17. Which of the following pre-treatments is specifically designed to eliminate anaerobic spore-forming bacteria from milk intended for cheese making without utilizing severe heat treatment?
(A) Bactofugation
(B) Thermization
(C) High-Temperature Short-Time (HTST) pasteurization
(D) Homogenization

2023

18. Microfiltration of cheese milk typically utilizes ceramic membranes with a specific pore size to separate bacteria from the milk. What is the standard pore size utilized for this purpose?
(A) 0.001 to 0.01 micrometers
(B) 0.1 to 0.2 micrometers
(C) 1.4 to 2.0 micrometers
(D) 10 to 15 micrometers

2014

19. What is the fundamental difference between thermization and pasteurization of cheese milk?
(A) Thermization is a milder treatment (60-65°C, 15s) to limit psychrotrophs rather than ensure pasteurization-level safety.
(B) Thermization is designed to completely destroy alkaline phosphatase, whereas standard pasteurization is not intended for this.
(C) Thermization denatures whey proteins to increase cheese yield, whereas pasteurization actively prevents such denaturation.
(D) Thermization requires holding milk at 85°C for 30 minutes, whereas pasteurization requires heating to 72°C for 15 seconds.

2006

20. Which of the following processing combinations is most appropriate to maximize cheese yield while preventing late blowing in Gouda?
(A) Homogenization followed by ultra-high temperature sterilization
(B) Thermization followed directly by high-pressure homogenization
(C) Microfiltration of whole milk followed by direct vat inoculation
(D) Standardization followed by bactofugation and HTST pasteurization

2003

21. What is the biochemical role of adding calcium chloride to milk prior to renneting?
(A) It functions as a powerful chemical preservative against post-pasteurization coliform contaminants.
(B) It restores the soluble calcium balance disrupted by processing, thereby enhancing overall coagulation.
(C) It partially denatures whey proteins, allowing them to become trapped within the solid casein matrix.
(D) It works to inhibit the excessive proteolytic action of indigenous milk plasmin during cheese ripening.

2001

22. Annatto is a common colorant used in cheeses like Cheddar. From which botanical source is annatto extracted?
(A) The crocus flower (Crocus sativus)
(B) The root of the turmeric plant (Curcuma longa)
(C) The seeds of the achiote tree (Bixa orellana)
(D) The leaves of the indigo plant (Indigofera tinctoria)

2024

23. What chemical agent is often used as a bleaching agent in the manufacture of blue-veined cheeses from cow's milk to decolorize the natural beta-carotene?
(A) Hydrogen peroxide
(B) Benzoyl peroxide
(C) Sodium hypochlorite
(D) Titanium dioxide

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2023

24. Exogenous lipases, often extracted from kid or calf pregastric glands, are traditionally added during the manufacture of which class of cheeses to develop a characteristic piquant flavor?
(A) Italian pasta-filata varieties such as Provolone and Romano
(B) Mild Cheddar cheeses aged for less than three months
(C) Surface mold-ripened varieties such as Camembert and Brie
(D) Fresh, unripened soft cheeses like traditional Cottage cheese

2016

25. Consider the following statements regarding cheese additives:
I. Calcium chloride addition usually ranges between 0.01% and 0.02% in cheese milk.
II. Lipases are added to Cottage cheese to enhance its rapid maturation.
III. Annatto color is stable at low pH and remains bound to the casein matrix during coagulation.
Which of the above statements are correct?
(A) I and II
(B) II and III
(C) I and III
(D) I, II and III

2004

26. Which lactic acid bacteria species is classified as a thermophilic starter culture essential for the manufacture of Swiss and Mozzarella cheese?
(A) Lactococcus lactis subsp. cremoris
(B) Streptococcus thermophilus
(C) Leuconostoc mesenteroides subsp. cremoris
(D) Lacticaseibacillus casei

2012

27. What is the primary metabolic function of Leuconostoc species when included in a mesophilic starter culture for Gouda or Edam cheese?
(A) Metabolism of citrate to produce diacetyl and carbon dioxide for flavor and eye formation
(B) Rapid production of high levels of lactic acid to drop the substrate pH below 4.5 quickly
(C) Synthesis of propionic acid and carbon dioxide to facilitate large eye formation during aging
(D) Release of intracellular peptidases for extremely rapid proteolysis and accelerated ripening

2019

28. In the symbiotic relationship between Streptococcus thermophilus and Lactobacillus delbrueckii subsp. bulgaricus, what specific growth factor does L. bulgaricus primarily provide to S. thermophilus?
(A) Formic acid and purine precursors
(B) Carbon dioxide and pyruvate
(C) Free amino acids and peptides
(D) Diacetyl and acetoin compounds

2016

29. Which of the following represents an INCORRECT pairing of a starter culture type with its optimal growth temperature range?
(A) Mesophilic O-culture: 25-30°C
(B) Thermophilic cultures: 37-45°C
(C) Mesophilic LD-culture: 25-30°C
(D) Psychrophilic starters: 10-15°C

2002

30. What characterizes an undefined (artisanal) starter culture compared to a defined single-strain starter?
(A) They contain a known, precise mixture of explicitly characterized bacterial strains.
(B) They are highly susceptible to sudden, devastating bacteriophage-induced failure.
(C) They consist of a complex, uncharacterized mixture of strains offering high phage resistance.
(D) They are manufactured exclusively using advanced recombinant DNA engineering methods.

2004

31. Which of the following is NOT a characteristic of microbial coagulants used in cheese making?
(A) They are typically derived from fungi such as Rhizomucor miehei.
(B) They possess exactly the same proteolytic specificity as calf chymosin.
(C) They are often more heat-stable than animal rennet.
(D) Their excessive non-specific proteolysis can lead to a bitter flavor in aged cheese.

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2017

32. Recombinant chymosin, widely used in modern cheese making, is synthesized by inserting the bovine chymosin gene into which of the following host organisms?
(A) Streptococcus thermophilus and related thermophiles
(B) Penicillium roqueforti or related mold species

199. (B) It measures the volume of air incorporated, where higher overrun corresponds to a fluffier, less dense foam structure
Overrun is a fundamental physical parameter in aerated dairy systems that quantifies the volume of air incorporated relative to the initial liquid mix. A higher overrun indicates a larger proportion of entrapped air bubbles, which directly results in a fluffier, softer, and less dense foam structure, significantly impacting the sensory texture and melting rate of whipped cream.

200. (C) Cone-and-plate
Cone-and-plate geometries are highly sensitive to edge failure when testing elastic dairy gels at high rotational speeds. This failure occurs when centrifugal forces exceed the sample surface tension, causing the gel to pull away from the outer edge of the geometry or spill out of the gap. This loss of sample contact prevents accurate stress and viscosity calculations.

201. (D) The ratio of solid fat crystals to liquid oil
The spreadability of butter at refrigeration temperatures is determined by the solid-to-liquid fat ratio. Milk fat contains a complex mixture of triacylglycerols that melt over a wide temperature range. A high proportion of solid fat crystals creates a rigid crystal network, reducing spreadability, whereas a higher liquid oil fraction allows the crystal planes to slide, improving spreadability.

202. (A) Hardness decreases as the protein matrix is broken down
During cheese ripening, primary proteolysis pathways break down the rigid, three-dimensional para-casein protein matrix into smaller, soluble peptides and amino acids. As this structural skeleton is progressively hydrolyzed, its capacity to resist compressive forces declines. Consequently, the textural hardness of the cheese decreases over time, transitioning the curd from a firm to a softer, more pliable texture.

203. (B) Extensional viscosity
Extensional viscosity describes the resistance of a fluid to stretching or elongational flow, rather than shear flow. This rheological property is highly relevant for melted Mozzarella cheese, where it governs the ability of the cheese to form long, continuous, and unbroken threads when stretched. This stringiness is a key sensory attribute desired in pizza applications.

204. (B) It depresses foaming by spreading over the interface and rupturing the protein film
Free fat is a highly effective anti-foaming agent in dairy systems. When liquid fat is present in skim milk, it migrates to the air-water interface and spreads over the surface. This spreading action displaces the elastic protein film that stabilizes the air bubbles. Because the lipid film lacks viscoelasticity, it easily ruptures, causing rapid bubble coalescence and collapse.

205. (A) The gap can be adjusted to be larger than the particulates, preventing jamming
Testing dairy products containing large particulates, such as fruit yogurt, presents challenges for narrow-gap rheometers. Parallel plate geometries are preferred for these systems because the gap height can be adjusted. Setting a larger gap ensures the distance between plates is at least ten times larger than the particle size, preventing mechanical jamming and ensuring representative bulk measurements.

206. (C) Friction coefficient increase due to salivary boundary layer depletion
Astringency is a tactile oral sensation predicted using tribology. Whey proteins can interact with and precipitate salivary proline-rich proteins, disrupting the protective, lubricating boundary layer on oral tissues. This depletion of salivary lubrication leads to a significant increase in the friction coefficient between sliding oral surfaces, which correlates directly with the sensory perception of dryness and mouth-coating.

207. (A) P-2, Q-4, R-1, S-3
Dairy stabilizers exhibit unique functional properties. Kappa-carrageenan forms weak thixotropic gels with casein to prevent phase separation in chocolate milk. High-methoxyl pectin protects proteins from acid-induced aggregation via steric hindrance. Sodium alginate reacts with calcium to form cold-setting gels, and xanthan gum is highly pseudoplastic and cold-soluble, making it ideal for suspending particles in dairy beverages.

208. (C) $\sigma = \sigma_0 + \eta_p \dot{\gamma}$
The Bingham plastic model describes materials that exhibit an initial resistance to flow. The fundamental equation relates shear stress to

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calcium chloride
(B) Lowering the milk pH to 6.2 prior to renneting
(C) Adding a high dosage of mesophilic starter culture
(D) Holding the milk at a temperature below 15°C

2007

40. Consider the following statements regarding coagulation mechanisms:
I. The primary phase of renneting has a $Q_{\{10\}}$ of roughly 2.
II. The secondary phase of renneting has a $Q_{\{10\}}$ greater than 10.
III. Acid coagulation leaves most of the calcium inside the casein micelle.
IV. Rennet coagulation retains the majority of colloidal calcium phosphate in the curd.
V. High pasteurization temperatures improve rennet coagulation by denaturing whey proteins.
Which of the above statements are correct?
(A) I, II and IV
(B) II, III and V
(C) I, III and IV
(D) I, IV and V

2014

41. In the traditional manufacture of Cheddar cheese, what is the primary biochemical and physical objective of the "cheddaring" process?
(A) To rapidly cool curd blocks and halt starter activity
(B) To drain whey, develop acid, and align protein fibers
(C) To incorporate air into the curd to ensure eye formation
(D) To wash curd with water to prevent excessive lactic acidity

2002

42. What specific defect will most likely occur in Cheddar cheese if the curd is milled and salted at too high a pH (e.g., pH 5.9)?
(A) The cheese will develop a highly crumbly, acid-like body and an undesirable metallic flavor profile.
(B) The cheese will remain excessively soft, retain too much moisture, and fail to develop typical flavor.
(C) The cheese will undergo rapid early gas production, resulting in massive holes within twenty-four hours.
(D) The cheese will experience early breakdown of milk fat, leading to immediate lipolytic rancidity defects.

2008

43. Which microorganism is strictly responsible for the characteristic "eye" formation in Swiss cheese (Emmental)?
(A) Propionibacterium freudenreichii subsp. shermanii
(B) Leuconostoc mesenteroides subsp. cremoris strains
(C) Penicillium roqueforti mold-ripening cultures
(D) Brevibacterium linens surface-smear bacteria

2007

44. What are the key biochemical products of the fermentation reaction that causes eye formation in Swiss cheese?
(A) Lactic acid, ethanol, and dissolved oxygen molecules
(B) Butyric acid, hydrogen gas, and bound water molecules
(C) Propionic acid, acetic acid, and carbon dioxide gas
(D) Diacetyl, acetoin, and volatile carbon dioxide gas

2014

45. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): Emmental (Swiss) cheese is traditionally manufactured using thermophilic starter cultures rather than mesophilic ones.
Reason (R): The curd for Emmental is subjected to a high-temperature "cooking" step (around 50-54°C) to expel moisture, which mesophilic cultures cannot survive.
Based on these statements, choose the correct option:
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2012

46. During Gouda cheese manufacturing, a critical processing step involves drawing off a portion of the whey and replacing it with warm water. What is the primary purpose of this "curd washing" step?
(A) To thermally inactivate the added mesophilic starter cultures during processing.

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2016

106. Enzymatic hydrolysis of milk proteins is frequently utilized to produce bioactive peptides. Which sequence in bovine beta-casein contains the most well-characterized ACE-inhibitory peptides (e.g., Val-Pro-Pro, Ile-Pro-Pro)?
(A) Hydrophilic N-terminal regions of the casein chain.
(B) Proline-rich sequences released by L. helveticus.
(C) The glycomacropeptide (GMP) region of kappa-casein.
(D) The internal disulfide loop of alpha-lactalbumin.

2004

107. Angiotensin-converting enzyme (ACE) inhibitory peptides derived from milk protein hydrolysates offer which specific therapeutic health benefit?
(A) Lowering of elevated systemic blood pressure (antihypertensive action).
(B) Drastic and immediate reduction of blood glucose levels in diabetics.
(C) Promotion of rapid biological blood clotting in hemophiliac patients.
(D) Complete mechanical eradication of active intestinal parasite populations.

2017

108. Lactoferricin is a well-known antimicrobial peptide. From which milk protein is it derived following enzymatic hydrolysis by pepsin?
(A) Beta-lactoglobulin
(B) Alpha-s1-casein
(C) Lactoferrin
(D) Serum albumin

2003

109. What is a common negative sensory consequence of extensive, unguided enzymatic hydrolysis of milk proteins when producing protein hydrolysates for infant formula or sports drinks?
(A) The rapid biological development of an intense dark blue color.
(B) Excessive, cloying sweetness that masks all desirable notes.
(C) Immediate thermal volatilization of essential free amino acids.
(D) Bitter taste development due to exposed hydrophobic residues.

2006

110. The production of hypoallergenic infant formula relies on the extensive enzymatic hydrolysis of cow's milk proteins. What is the fundamental immunological goal of this process?
(A) To increase overall protein size, thereby completely preventing direct intestinal absorption.
(B) To biochemically convert allergen proteins into fully inert and indigestible dietary fiber.
(C) To destroy protein epitopes that trigger allergic IgE immune responses in susceptible infants.
(D) To synthesize human milk immunoglobulins artificially within the cow's milk serum phase.

2009

111. Which commercial enzyme preparation is predominantly used for the large-scale production of milk protein hydrolysates designed to yield specific bioactive peptides?
(A) Purified recombinant bovine chymosin acting on terminal caseins.
(B) Microbial proteases like Alcalase or food-grade lactic extracts.
(C) Highly purified bovine plasmin extracted from fresh animal serum.
(D) Exogenous pregastric esterases targeted at short-chain lipids.

2010

112. The hydrolysis of lactose by beta-galactosidase yields which two monosaccharides?
(A) Glucose and Fructose
(B) Galactose and Fructose
(C) Two molecules of Glucose
(D) Glucose and Galactose

2017

113. Aside from producing lactose-free milk for intolerant consumers, what physical advantage does lactose hydrolysis offer in the formulation of frozen dairy desserts like ice cream?
(A) It prevents sandiness defects from lactose crystallization.
(B) It raises the mix freezing point, increasing freezing rate.
(C) It completely eliminates the need for chemical emulsifiers.
(D) It causes the frozen dessert to glow under standard UV light.

2024

114. Ultrafiltration (UF) permeate from cheese manufacture is a large byproduct stream rich in lactose. Enzymatic hydrolysis of UF permeate is often performed to create sweet syrups. Why does hydrolysis increase the sweetness of the permeate?

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lactoferrin proteins under alkaline conditions.
(C) Heat-induced denaturation of whey proteins combined with acidification to their isoelectric points.
(D) Homogenization-induced complexing of polar milk fat globule membrane lipids and globulins.

2011

55. Match the cheese variety in List I with its defining manufacturing characteristic in List II:

List I: (Cheese Variety)
P. Cheddar
Q. Mozzarella
R. Ricotta
S. Cottage

List II: (Manufacturing Characteristic)
1. Heat-acid precipitation of whey proteins
2. Curd milling and dry salting
3. Acid coagulation to pH 4.6 and curd washing
4. Hot water stretching (plasticization)

(A) P-2, Q-4, R-1, S-3
(B) P-3, Q-4, R-1, S-2
(C) P-2, Q-1, R-4, S-3
(D) P-4, Q-2, R-3, S-1

2008

56. What is the primary function of emulsifying salts (e.g., sodium citrates and phosphates) in the manufacture of processed cheese?
(A) They sequester calcium from casein, hydrating proteins to form a stable fat-in-water emulsion.
(B) They act as highly effective food-grade antimicrobial preservatives against Clostridium species.
(C) They promote rapid, controlled crystallization of lactose to significantly improve mouthfeel.
(D) They induce the secondary non-enzymatic phase of rennet coagulation during the cooking stage.

2002

57. Which of the following defects is most likely to occur in processed cheese if insufficient emulsifying salts are used or the processing temperature is too low?
(A) Extreme hardening of the cheese block
(B) Separation of free fat and water during heating (oil-off)
(C) Excessive browning due to Maillard reactions
(D) Formation of calcium lactate crystals on the surface

2010

58. The concept of "creaming" during the manufacture of processed cheese refers to:
(A) The physical separation of free milk fat migrating to the surface of the melting kettle.
(B) The gradual increase in hot melt viscosity due to continuous agitation and protein hydration.
(C) The controlled addition of fresh dairy cream to increase the fat content of the final product.
(D) The high-shear physical whipping of the cooled product matrix to incorporate atmospheric air.

2001

59. Which specific formulation parameter distinguishes "cheese spreads" from standard "processed cheese" blocks?
(A) Spreads have higher moisture and use short-chain phosphates or citrates for a softer texture.
(B) Spreads contain exclusively highly mature natural cheese as the sole raw material source.
(C) Spreads prohibit the addition of any non-cheese dairy ingredients during formulation.
(D) Spreads are manufactured under specialized cold-press conditions without applying heat.

2009

60. Which of the following is INCORRECT regarding the raw material blend used in processed cheese manufacturing?
(A) A blend of young (mild) and aged (mature) cheese is used to balance flavor and functional protein intactness.
(B) Using only very old, mature cheese results in a short, brittle texture due to heavily degraded casein.
(C) Emulsifying salts are strictly limited to sodium chloride and potassium chloride.
(D) The pH of the processed cheese melt is typically adjusted to between 5.6 and 6.0 for optimal emulsion stability.

2009

61. In the context of modern commercial cheese manufacturing, what is an "Alcurd" or similar continuous coagulator designed to achieve?
(A) The continuous mechanical stretching and molding of hot pasta-filata curd.
(B) The automated dosing and uniform dry salting of milled cheese curd blocks.

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(C) The high-pressure, mechanized pressing of traditional Swiss cheese wheels.
(D) The continuous coagulation of milk flowing in channels via cold-renneting.

2022
62. Which of the following best describes the function of a Double O (OO) cheese vat?
(A) It is a holding vessel used solely for the prolonged curing and aging of hard Parmesan cheese.
(B) It is a specialized vat operating under high vacuum to continuously extract whey from Cottage curd.
(C) It is an enclosed vat with overlapping agitation zones designed for efficient mechanized curd cutting.
(D) It is an insulated surge tank utilized exclusively for the low-temperature thermization of milk.

2017
63. Mechanized cheddaring machines, such as the Alf-O-Matic or the Bell-Siro Cheesemaker, replicate the traditional cheddaring process. What physical action do these machines primarily automate?
(A) The uniform surface inoculation of Camembert curd using Penicillium camemberti spore solutions.
(B) The knitting, matting, flow, and inversion of curd blocks on a continuous draining conveyor belt.
(C) The continuous dilution and washing of Gouda curd using high-temperature, pasteurized wash water.
(D) The high-speed physical stretching and mechanical molding of hot, plasticized pasta-filata curds.

2005
64. What is the main operational advantage of a continuous deep-channel brining system over static shallow brine tanks?
(A) It extends immersion times by holding cheese blocks submerged for twice the standard duration.
(B) It reduces overall salt penetration to achieve highly controlled low-sodium content in cheeses.
(C) It actively inhibits the growth of beneficial yeast and smear bacteria on surface-ripened types.
(D) It ensures a first-in, first-out flow of blocks, maximizing space and automating loading systems.

2023
65. Consider the following statements concerning cheese mechanization:
I. Enclosed mechanized vats improve hygiene and allow for clean-in-place (CIP) protocols.
II. Blockformers automate the pressing of milled, salted Cheddar curd into solid blocks under vacuum.
III. Mechanized systems have completely eliminated the need for starter cultures in large-scale operations.
Which of the above statements is/are correct?
(A) I and II
(B) II and III
(C) I and III
(D) I, II and III

2006
66. During cheese ripening, glycolysis primarily refers to which biochemical event?
(A) The deep proteolytic breakdown of intact casein into small peptides and free amino acids.
(B) The lipolytic hydrolysis of core milkfat triglycerides into free short-chain fatty acids.
(C) The metabolic conversion of residual lactose to lactic acid by starter and non-starter bacteria.
(D) The multi-step enzymatic metabolism of milk citrate into diacetyl and volatile carbon dioxide.

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2002
67. Which of the following biochemical pathways is most responsible for the development of fundamental background flavor and the structural softening of hard cheeses during prolonged ripening?
(A) Proteolysis
(B) Glycolysis
(C) Lipolysis
(D) Citrate fermentation

2023
68. The initial proteolytic degradation of alpha-s1-casein during cheese ripening is predominantly catalyzed by which enzyme?
(A) Plasmin (endogenous milk protease)
(B) Lipoprotein lipase
(C) Beta-galactosidase
(D) Chymosin (retained coagulant)

2021

69. Endogenous milk plasmin plays a crucial role in the ripening of high-cook cheeses like Swiss. Which casein fraction is the preferred substrate for plasmin?
(A) Alpha-s1-casein
(B) Beta-casein
(C) Kappa-casein
(D) Gamma-casein

2009

70. Extensive lipolysis is a critical ripening requirement for which of the following cheese varieties, contributing heavily to its characteristic peppery flavor?
(A) Mild Cheddar cheese
(B) Semi-hard Gouda cheese
(C) Blue-veined cheese
(D) Pasta-filata Mozzarella

2016

71. When attempting to accelerate cheese ripening through elevated storage temperatures (e.g., 15°C instead of 8°C), what is the most significant commercial risk?
(A) The absolute cessation of all enzymatic and proteolytic activity within the cheese matrix.
(B) The thermodynamic conversion of lactic acid back into fermentable milk lactose molecules.
(C) The rapid, uncontrolled precipitation of soluble calcium phosphate out of the cheese curd.
(D) Unbalanced flavor profiles and the rapid proliferation of spoilage or pathogenic microbes.

2004

72. Attenuated starter cultures are used in accelerated cheese ripening. What does "attenuation" mean in this context?
(A) Treating cells so they cannot produce acid, while keeping their intracellular ripening enzymes active.
(B) Genetically modifying the bacterial genome to produce excessive amounts of propionic acid during aging.
(C) Subjecting starter cultures to specialized spray-drying or freeze-drying to extend stable shelf life.
(D) Isolating and purifying strictly the active lipolytic enzyme fractions directly from the bacteria.

2011

73. Which exogenous enzyme combination would most effectively accelerate the overall ripening profile (flavor and texture) of a Cheddar-type cheese without inducing severe bitterness?
(A) Single high-dosage additions of raw animal lipases into the milk.
(B) A balanced mixture of microencapsulated proteinases and peptidases.
(C) Purified exogenous plasmin enzymes added directly to the drained curd.
(D) Recombinant bovine chymosin applied in double the standard dosages.

2021

74. Why is microencapsulation specifically beneficial when adding exogenous enzymes to cheese milk for accelerated ripening?
(A) It prevents active enzymes from denaturing during standard thermal pasteurization steps.
(B) It prevents premature protein degradation, trapping enzymes in curd for slow release during aging.
(C) It causes the enzymes to partition exclusively into the runoff whey, leaving the curd untouched.
(D) It accelerates the enzymic coagulation phase by continuously releasing soluble calcium ions.

2015

75. Consider the following statements regarding accelerated cheese ripening methodologies:
I. Elevated ripening temperatures reduce the time required but increase the risk of microbiological spoilage.
II. Addition of specific peptidases helps debitter cheese by breaking down bitter hydrophobic peptides.
III. Attenuated starters contribute to acid production during the coagulation phase.
IV. Exogenous lipases are rarely used in accelerated ripening of pasta-filata cheeses.
Which of the above statements are correct?
(A) I and II
(B) I, II and IV
(C) II, III and IV
(D) I and IV

2005

76. The "early blowing" defect in cheese, characterized by spongy texture and small gas holes shortly after manufacture, is primarily caused by which organism?
(A) Clostridium tyrobutyricum
(B) Penicillium camemberti
(C) Escherichia coli and Enterobacter aerogenes

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2019

92. A "ropy" or excessively viscous texture in yoghurt is typically caused by:
(A) The rapid superficial growth of wild yeast contaminants.
(B) Proteolytic breakdown by psychrotrophic contamination.
(C) EPS production by certain strains of starter bacteria.
(D) Excessive additions of calcium chloride during formulation.

2017

93. According to FAO/WHO criteria, which of the following is a mandatory prerequisite for a microbial strain to be classified as a "probiotic"?
(A) It must be isolated from healthy humans to ensure absolute host compatibility and safety.
(B) It must be heat-inactivated to completely prevent any potential of opportunistic infection.
(C) It must possess the ability to fully eradicate all competing native gastrointestinal flora.
(D) It must survive passage through stomach acid and small intestine bile salts to remain active.

2004

94. The term "synbiotic" refers to a product that contains:
(A) A complex mixture containing both mesophilic and thermophilic starter strains.
(B) Both animal and plant proteins.
(C) A synergistic combination of live probiotics and selective prebiotic substrates.
(D) A system using recombinant enzymes and natural biological extracts in co-dependency.

2013

95. Match the bioactive component in List I with its specific function or definition in functional dairy products in List II:
List I: (Bioactive Component)
P. Bifidobacterium animalis
Q. Inulin
R. Nisin
S. Conjugated Linoleic Acid (CLA)
List II: (Function/Definition)
1. An antimicrobial peptide used as a bio-preservative
2. A non-digestible oligosaccharide acting as a prebiotic
3. A well-documented probiotic strain known for gut colonization
4. A functional fatty acid with potential health benefits
(A) P-3, Q-2, R-1, S-4
(B) P-2, Q-3, R-4, S-1
(C) P-3, Q-1, R-2, S-4
(D) P-1, Q-4, R-3, S-2

2014

96. Which of the following prebiotics is naturally synthesized in small amounts by certain lactic acid bacteria via transgalactosylation and is highly bifidogenic?
(A) Fructooligosaccharides (FOS)
(B) Pectin
(C) Cellulose
(D) Galactooligosaccharides (GOS)

2022

97. What is the most significant technological challenge when incorporating live probiotic strains, such as Lactobacillus acidophilus, into standard stirred yoghurt?
(A) Probiotics die off during cold storage due to low pH and acid accumulation from starters.
(B) Probiotics aggressively ferment lactose into propionic acid, causing severe flavor defects.
(C) Probiotics prevent proper gel coagulation by hydrolyzing the structural kappa-casein network.
(D) Probiotics require a strictly aerobic high-oxygen environment to maintain cellular survival.

NODIA

2005

98. Which mechanism primarily explains the cholesterol-lowering therapeutic benefit proposed for certain probiotic dairy products?
(A) Probiotics absorb and sequester dietary fat prior to reaching the human small intestine.
(B) Probiotics synthesize enzymes that degrade serum cholesterol into water and carbon dioxide.
(C) Probiotics deconjugate bile salts via BSH, causing serum cholesterol use for new bile acids.
(D) Probiotics physically inhibit the mechanical breakdown of dietary fat micelles in the stomach.

2004

99. The application of recombinant DNA (rDNA) technology in dairy starter cultures faces strict commercial limitations globally primarily because:
(A) There are severe regulatory hurdles and

2015

85. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): The yield of chakka from buffalo milk is significantly higher than that from cow milk.
Reason (R): Buffalo milk possesses a higher total solids content, specifically higher casein and fat levels, which form the bulk of the strained chakka mass.
Based on these statements, choose the correct option:
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2010

86. Which of the following statements is INCORRECT regarding the standardized formulations of traditional fermented Indian dairy products?
(A) Shrikhand typically contains 40-45% sugar on a dry matter basis.
(B) Standardized dahi requires a specific fat level matching the type of milk (e.g., toned, standardized) used for its preparation.
(C) Misti dohi is fermented strictly by mesophilic yeast cultures to produce ethanol.
(D) Industrial production of lassi utilizes homogenization to prevent whey separation (syneresis) during storage.

2009

87. In the industrial manufacturing of yoghurt, milk is typically subjected to a severe heat treatment (e.g., 85°C for 30 mins or 90-95°C for 5 mins). What is the primary functional reason for this?
(A) To sterilize the cheese milk by destroying all highly heat-resistant bacterial spores.
(B) To cause heavy caramelization of milk lactose to impart a characteristic brown color.
(C) To induce the complete precipitation of soluble calcium phosphate salts from the serum.
(D) To denature beta-lactoglobulin to interact with kappa-casein, reducing syneresis.

2011

88. Yoghurt relies on the symbiotic relationship between Streptococcus thermophilus (ST) and Lactobacillus delbrueckii subsp. bulgaricus (LB). How does ST assist LB during the initial stages of fermentation?
(A) ST produces formic acid, pyruvic acid, and carbon dioxide, which stimulate the growth of LB.
(B) ST produces large amounts of lactic acid that immediately lowers the pH to 4.0, which LB requires to start growing.
(C) ST extensively hydrolyzes milk proteins into peptides for LB.
(D) ST rapidly ferments galactose, removing it from the medium.

2002

89. What is the fundamental difference in the processing lines of "set" yoghurt versus "stirred" yoghurt?
(A) Set yoghurt excludes Lactobacillus species from the starter blend, whereas stirred yoghurt utilizes them.
(B) Set yoghurt is fermented in retail packages, while stirred yoghurt is incubated in bulk and agitated.
(C) Stirred yoghurt undergoes a specialized low-temperature baking step immediately following fermentation.
(D) Set yoghurt requires active rennet addition to form gels, while stirred yoghurt relies only on acid.

2012

90. Which flavor compound is considered the most characteristic and essential for the typical flavor profile of plain yoghurt?
(A) Diacetyl
(B) Acetaldehyde
(C) Propionic acid
(D) Ethanol

2002

91. Excessive syneresis (wheying-off) is a common defect in set yoghurt. Which of the following is NOT a recognized preventive measure against syneresis?
(A) Agitating the yoghurt immediately before it reaches its final pH of 4.5
(B) Increasing the total solids of the milk (e.g., adding skim milk powder)
(C) Applying appropriate high-heat treatment to the cheese milk
(D) Utilizing exopolysaccharide (EPS) producing strains of starter cultures

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(B) To selectively extract milk fat from the curd to meet medium-fat classification standards.
(C) To remove excess lactose, limiting post-pressing acidity to maintain a final pH around 5.2.
(D) To sanitize the curd matrix from potential contamination by pathogenic coliform organisms.

2013

47. Which processing step is the defining characteristic of "pasta-filata" cheeses like Mozzarella?
(A) Maturation in high-humidity caves for surface mold growth
(B) Plasticization of the acidified curd in hot water, followed by stretching and molding
(C) Milling and dry-salting the curd prior to heavy mechanical pressing
(D) Coagulation strictly through the use of organic acids without any enzymatic intervention

2011

48. What is the optimal curd pH range for achieving maximum stretchability and meltability during the plasticization step of Mozzarella cheese manufacturing?
(A) 4.5 to 4.7
(B) 5.1 to 5.4
(C) 5.8 to 6.1
(D) 6.4 to 6.6

2015

49. In the production of Gouda, the cheese is typically salted by immersion in a brine solution rather than dry salting. Which of the following is an advantage of brining over dry salting?
(A) It provides uniform salt distribution and forms a firm outer rind.
(B) It drastically accelerates the rate of whey drainage during pressing.
(C) It completely eliminates the requirement for any starter cultures.
(D) It prevents undesirable moisture loss throughout the ripening period.

2011

50. Which of the following statements INCORRECTLY compares Gouda and Cheddar cheese making?
(A) Cheddar involves a dry salting step prior to hooping, whereas Gouda relies on brine salting after pressing.
(B) Gouda utilizes a curd washing step to control acidity, whereas Cheddar relies on the cheddaring process for moisture and acid control.
(C) Gouda requires high-temperature cooking (54°C) like Swiss cheese, whereas Cheddar does not.
(D) Cheddar has a typical final pH lower than that of standard Gouda cheese.

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2008

51. Cottage cheese is primarily classified as which type of cheese?
(A) Acid-coagulated soft unripened cheese
(B) Rennet-coagulated hard cheese
(C) Surface-ripened semi-soft cheese
(D) Heat-acid precipitated whey cheese

2001

52. Which of the following best describes the traditional method of curd formation in Cottage cheese?
(A) Rapid enzymatic coagulation using high levels of recombinant chymosin at near-neutral pH values.
(B) Thermal precipitation of standardized milk at 90°C using food-grade organic citric acid.
(C) Thermal evaporation of natural milk moisture under high vacuum until a dense curd mass forms.
(D) Slow microbial acidification to pH 4.6, often utilizing a trace amount of rennet for curd firmness.

2008

53. Quark is a popular European soft cheese. Which step is essential in the modern industrial production of Quark to separate the whey from the acid-coagulated curd?
(A) Extensive physical cheddaring and curd milling steps
(B) High-speed centrifugal separation using a quark separator
(C) Direct plasticization of the curd in heated water baths
(D) Immersion of curd blocks in concentrated brine solutions

2009

54. Ricotta is traditionally classified as a whey cheese. What is the fundamental mechanism of its protein coagulation?
(A) Enzymatic cleavage of kappa-casein by residual active rennet present in the whey source.
(B) Cold-induced physical aggregation of native

negative consumer perception regarding food GMOs.
(B) Genetically modified lactic acid bacteria completely lose their ability to synthesize acid.
(C) Foreign plasmids introduced via genetic engineering always trigger severe bacteriophage lysis.
(D) Recombinant DNA manipulations invariably lead to the synthesis of lethal dairy enterotoxins.

2009

100. Consider the following statements regarding genetic engineering of dairy starters:
I. Phage resistance mechanisms can be engineered into Lactococcus lactis using plasmid transfer.
II. Genetically modified starters have completely replaced traditional starters in European cheese making.
III. Engineering starters to lack lactate dehydrogenase (LDH) would improve their performance in standard cheese making.
IV. Exopolysaccharide (EPS) production can be enhanced by overexpressing specific gene clusters.
V. Gene editing tools like CRISPR-Cas systems can be used to immunize starter cultures against specific bacteriophages.
Which of the above statements are correct?
(A) I, II and III
(B) I, IV and V
(C) II, III and V
(D) I, III and IV

2023

101. Which plasmid-encoded trait is frequently targeted for transfer or stabilization in Lactococcus lactis starter cultures via natural conjugation or recombinant methods?
(A) The biological ability to fix gaseous atmospheric nitrogen in milk.
(B) Resistance to lytic bacteriophages via abortive infection systems.
(C) The toxigenic production of harmful aflatoxins during fermentation.
(D) Cellular resistance to extremely high thermal pasteurization regimes.

2010

102. When dairy enzymes are immobilized on a solid support (e.g., for continuous lactose hydrolysis), which of the following is a primary kinetic consequence?
(A) The maximum velocity ($V_{\{}\max_{\}}$) of the reaction increases infinitely.
(B) The enzyme loses its substrate specificity, attacking structural proteins.
(C) The apparent Michaelis constant (K_m) increases due to mass transfer limits.
(D) The optimum pH profile of the active enzyme shifts strictly to 1.0.

2002

103. What is a major commercial advantage of using immobilized beta-galactosidase reactors for producing lactose-free milk compared to adding free enzyme directly to the milk tank?
(A) The support matrix alters the dairy nutritional profile by adding dietary fiber.
(B) The immobilized reactor system requires zero active thermal regulation during use.
(C) The physical binding process simultaneously pasteurizes the raw milk substrate.
(D) The enzyme can be reused continuously without remaining in the final food product.

2007

104. In dairy enzyme biotechnology, microencapsulation of ripening enzymes into liposomes serves primarily to:
(A) Ensure uniform distribution in milk, prevent early casein breakdown, and release enzymes slowly.
(B) Modify the chemical structure of animal-derived caseins to make them fully suitable for vegans.
(C) Actively trap invading bacteriophages and prevent them from attacking sensitive starter cells.
(D) Biosynthesize conjugated linoleic acid directly from denatured whey protein fractions in milk.

NODIA

2013

105. Consider the following statements regarding dairy enzyme biotechnology:
I. Exogenous free enzymes added to cheese milk are largely lost in the whey.
II. Immobilized enzymes are highly suitable for batch production of Cheddar curd.
III. Liposomes used for microencapsulation can be formulated to degrade at specific pH or temperatures.
Which of the above statements is/are correct?
(A) I and II
(B) I and III
(C) II and III
(D) I, II and III

(D) Propionibacterium freudenreichii

2008

77. The "late blowing" defect, typically appearing after several weeks of ripening in cheeses like Gouda and Emmental, is caused by the fermentation of lactic acid into which compounds?
(A) Volatile lactic acid and ethyl alcohol
(B) Propionic acid and volatile acetic acid
(C) Acetaldehyde and volatile diacetyl compounds
(D) Butyric acid, carbon dioxide, and hydrogen gas

2008

78. Which technological intervention is explicitly utilized to prevent the late blowing defect in susceptible semi-hard cheeses?
(A) The addition of high concentrations of water-soluble annatto color.
(B) The utilization of ultra-high temperature sterilization on cheese milk.
(C) The use of bactofugation or addition of lysozyme/nitrates to the milk.
(D) The severe reduction of sodium chloride concentration in the brine bath.

2008

79. Bitter flavor defect in matured Cheddar cheese is most frequently attributed to:
(A) Excessive auto-oxidation of unsaturated free fatty acids during storage.
(B) The accumulation of low-weight hydrophobic peptides from unbalanced proteolysis.
(C) The heavy, uncontrolled biochemical accumulation of volatile diacetyl compounds.
(D) The rapid conversion of residual lactose into galactose by starter bacteria.

2001

80. Consider the following statements concerning cheese defects:
I. Calcium lactate crystallization causes white specks on the surface of mature Cheddar, often mistaken for mold.
II. Pink discoloration in certain cheeses can be linked to the Maillard reaction or specific thermophilic bacteria.
III. Early blowing can be effectively controlled by good milking hygiene and proper milk pasteurization.
IV. Excessive moisture in the final cheese block reduces the incidence of bitter defects.
V. Late blowing is caused by coliforms surviving pasteurization.
Which of the above statements are correct?
(A) I, II and III
(B) II, III and V
(C) I, III and IV
(D) I, IV and V

2016

81. Traditional Indian dahi is produced by the natural or starter-induced fermentation of milk. According to FSSAI, what is the required minimum titratable acidity (as lactic acid) for dahi?
(A) 0.3%
(B) 0.6%
(C) 1.2%
(D) 1.5%

2014

82. Lassi is best described technologically as:
(A) A concentrated, sweetened, and strained fermented milk paste known as chakka.
(B) A soft, heat-acid precipitated direct-acidified cheese curd similar to paneer.
(C) A stirred fermented drink prepared by blending dahi with water and sweeteners.
(D) A clarified beverage produced through the active yeast fermentation of fluid whey.

2013

83. Misti dohi, a traditional fermented milk product popular in Eastern India, owes its characteristic brown color and caramel flavor primarily to:
(A) Extended heating of sweetened milk prior to inoculation, causing Maillard browning.
(B) High-dose addition of natural water-soluble annatto colorants before curd setting.
(C) Chromogenic pigment production by specialized lactobacilli strains during ripening.
(D) Systematic addition of synthetic yellow-brown coal-tar food dyes prior to packaging.

2009

84. Which of the following defines the intermediate base material "chakka" in the production of shrikhand?
(A) It is the highly sweetened and flavored finished dessert product.
(B) It is the acid whey byproduct expelled during fermentation of misti dohi.
(C) It is a heavily salted, deep-fried snack made from fermented curd solids.
(D) It is the solid mass obtained by draining whey from dahi (strained curd).

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(A) The enzyme beta-galactosidase is inherently sweeter than sucrose.
(B) The enzymatic reaction removes inorganic bitter salts from permeate.
(C) Resulting glucose and galactose have higher sweetness than lactose.
(D) Hydrolysis synthesizes artificial high-intensity sweeteners in situ.

2019

115. Consider the following statements concerning lactose hydrolysis:
I. Commercial beta-galactosidase is commonly sourced from yeasts like Kluyveromyces lactis or molds like Aspergillus oryzae.
II. Galactooligosaccharides (GOS) can be formed as a byproduct of lactose hydrolysis due to the transgalactosylation activity of the enzyme.
III. Lactose-free milk generally undergoes less Maillard browning than regular milk upon UHT treatment.
IV. The optimum pH of fungal beta-galactosidase (e.g., A. oryzae) is generally acidic, making it suitable for acid whey hydrolysis.
Which of the above statements are correct?
(A) I, II and IV
(B) I, III and IV
(C) II, III and IV
(D) I, II and III

2015

116. Nisin is a potent bio-preservative widely used in the dairy industry. It is a polycyclic antibacterial peptide classified as a bacteriocin. Which organism naturally produces nisin?
(A) Streptococcus thermophilus
(B) Penicillium roqueforti
(C) Propionibacterium freudenreichii
(D) Lactococcus lactis subsp. lactis

2024

117. What is the specific biochemical mode of action by which nisin exhibits its antibacterial effect against Gram-positive bacteria?
(A) It blocks the RNA polymerase complex, thereby preventing the transcription of essential messenger RNA.
(B) It binds to lipid II, inhibiting cell wall synthesis, and forms pores in the cytoplasmic membrane.
(C) It directly denatures bacterial ribosomes, permanently halting the translation of cellular proteins.
(D) It competitively inhibits lactose transport by binding directly to the membrane-associated permease enzyme.

2023

118. Which group of microorganisms is nisin primarily effective against in commercial dairy applications, particularly processed cheese?
(A) Gram-negative bacteria, including pathogenic strains of Escherichia coli and Salmonella enterica.
(B) Spoilage molds and yeasts, with a focus on common genera like Penicillium and Candida.
(C) Gram-positive bacteria, especially the spore outgrowths of Clostridium and Bacillus species.
(D) Acid-tolerant bacterial viruses, specifically bacteriophages that attack starter cultures.

NODIA

2007

119. Natamycin (pimaricin) is another bio-preservative utilized in the dairy industry. What is its principal target spectrum and typical application?
(A) It targets Gram-negative bacteria and is mixed into cheese milk prior to coagulation.
(B) It prevents late blowing by killing anaerobic Clostridium spores within the cheese block.
(C) It acts as an antioxidant to prevent lipid oxidation and fat rancidity during ripening.
(D) It is an antifungal agent against yeasts and molds applied as a surface treatment to rinds.

2006

120. Consider the following statements regarding dairy bio-preservatives:
I. Pediocin is a bacteriocin that exhibits strong anti-listerial activity.
II. Natamycin acts by binding to ergosterol in the fungal cell membrane.
III. Nisin is highly effective against most Gram-negative bacteria without the use of chelating agents like EDTA.
IV. Both nisin and natamycin are approved as food additives globally, though dosage limits apply.
V. Nisin production by starters is highly desired in yoghurt because it stimulates L. bulgaricus.
Which of the above statements are correct?
(A) I, II and IV
(B) II, III and V
(C) I, III and IV
(D) I, II and V

2015

121. In cheese ripening, the "late gas" defect is distinct from "early blowing". Which of the following analytical indicators strongly suggests that a blowing defect in a 3-month-old Gouda is due to Clostridium tyrobutyricum rather than coliforms?

(A) The presence of high levels of lactic acid
(B) The presence of high levels of butyric acid
(C) The total absence of carbon dioxide in the gas pockets
(D) The high concentration of free amino acids

2021

122. Which process is standard practice to counteract the threat of late blowing in Swiss-type cheeses where the addition of nitrate or lysozyme is prohibited?

(A) Repeated application of natamycin suspension directly onto the cheese rind surface
(B) Bactofugation or microfiltration of the cheese milk prior to vat processing
(C) Elevating the cheese ripening room temperature to approximately 25 degrees Celsius
(D) Adding a high concentration of nisin-producing starter strains of Lactococcus lactis

2009

123. The coagulation time of milk during renneting is inversely proportional to enzyme concentration. If the rennet dosage is doubled under identical conditions, the primary coagulation time will theoretically:

(A) Remain unchanged
(B) Be halved
(C) Be doubled
(D) Drop to zero

2021

124. During cheese making, syneresis of the curd (expulsion of whey) is accelerated by all of the following EXCEPT:

(A) Increasing the curd cooking temperature
(B) Increasing the rate of acid production
(C) Decreasing the mechanical agitation of the curd
(D) Cutting the curd into smaller uniform pieces

2004

125. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).

Assertion (A): Homogenization of milk is strictly avoided in the standard manufacture of traditional hard cheeses like Cheddar and Swiss.

Reason (R): Homogenization reduces the size of fat globules and coats them with casein, which disrupts the contiguous casein matrix, leading to weak, crumbly curds and impaired syneresis.

(A) Both (A) and (R) are true and (R) is the correct explanation of (A).
(B) Both (A) and (R) are true but (R) is not the correct explanation of (A).
(C) (A) is true but (R) is false.
(D) (A) is false but (R) is true.

2014

126. A manufacturer wishes to produce a Cheddar cheese with a lower fat content but a texture similar to full-fat Cheddar. What processing modification is most appropriate to combat the typical rubbery texture of low-fat cheese?

(A) Significantly raising the curd cooking temperature and duration
(B) Eliminating the traditional block cheddaring step entirely
(C) Washing the curd to raise pH and increase moisture content
(D) Utilizing thermophilic starter cultures exclusively in the vat

2022

127. Which of the following represents the correct sequence of fundamental steps in the manufacture of Cheddar cheese?

(A) Coagulation → Cheddaring → Cutting → Salting → Cooking → Milling → Pressing
(B) Coagulation → Cutting → Cooking → Cheddaring → Milling → Salting → Pressing
(C) Coagulation → Cooking → Cutting → Milling → Cheddaring → Pressing → Salting
(D) Coagulation → Cutting → Milling → Cheddaring → Cooking → Salting → Pressing

2005

128. What is the fundamental biophysical distinction between an acid-coagulated curd (e.g., Cottage cheese) and a rennet-coagulated curd (e.g., Cheddar) regarding mineral retention?

(A) Acid curd retains nearly all original milk calcium in its protein network; rennet curd loses the majority of it to the whey.
(B) Both curd types retain identical amounts of total calcium, but the acid-coagulated curd retains higher levels of phosphorus.
(C) Acid curd retains only monovalent sodium ions in its structure, whereas rennet curd

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retains only monovalent potassium ions.

(D) Acid curd loses its colloidal calcium phosphate via solubilization at low pH; rennet curd retains it within the casein matrix.

2012

129. During the ripening of surface mold-ripened cheeses (e.g., Camembert), how does the metabolism of the surface flora affect the internal pH and texture of the cheese?

(A) The flora metabolizes lactic acid and produces ammonia, raising the pH and causing inward calcium migration and core softening.

(B) The surface flora rapidly synthesizes extra lactic acid, dropping the internal pH and causing the core texture to harden significantly.

(C) The flora actively consumes all available free moisture, causing the cheese body to become extremely dry, brittle, and crumbly.

(D) The flora produces substantial amounts of propionic acid, dropping the internal pH and initiating characteristic eye formation.

2014

130. Which of the following parameters does NOT directly influence the activity of calf chymosin during milk coagulation?

(A) Milk pH

(B) Soluble calcium concentration

(C) Lactose concentration

(D) Temperature

2008

131. In processed cheese manufacture, if the pH of the blend drops too low (e.g., below 5.2) due to the use of overly mature and acidic cheese, what textural defect is most likely to manifest in the final product?

(A) The cheese will exhibit a crumbly, mealy texture as proteins approach their isoelectric point and lose emulsifying capacity.

(B) The cheese will become extremely soft, sticky, and highly flowable, completely losing its sliceable structure at room temperature.

(C) The cheese proteins will completely degrade, transforming the processed mass into a low-viscosity, transparent, watery fluid.

(D) The cheese will exhibit extreme, elastic stretchability and melt behavior highly reminiscent of fresh pasta-filata Mozzarella.

2004

132. How does the inclusion of sodium hexametaphosphate as an emulsifying salt influence the texture of processed cheese slices?

(A) It reacts with organic acids to induce massive, rapid gas formation and visible package expansion.

(B) It promotes a highly hydrated, very soft, and spreadable emulsion with increased flowability.

(C) It destabilizes the emulsion, causing immediate phase separation of the free fat and water.

(D) It sequester calcium and promotes firm protein cross-linking, resulting in a stable, sliceable texture.

NODIA

2014

133. Which processing parameter is highly critical for achieving the characteristic long, fibrous structure of pasta-filata cheeses during stretching?

(A) The addition of high concentrations of annatto colorant to enhance the visual appeal of the stretched fibers.

(B) Partial demineralization of the casein network at pH 5.2-5.4, followed by mechanical stretching in hot water.

(C) Maintaining the cheese curd at an alkaline pH strictly above 6.5 during the mechanical stretching process.

(D) The total, unrestricted solubilization of all colloidal calcium phosphate from the matrix prior to stretching.

2013

134. Which biochemical defect is associated with the phenomenon of "pinking" in Italian-type hard cheeses (like Parmesan or Romano)?

(A) Excessive production of diacetyl and other volatile flavor compounds by specific wild strains of mesophilic starters.

(B) Contamination by anaerobic Clostridium spores that germinate during the early stages of cheese block ripening.

(C) Reactions involving amino acid oxidation or interactions of specific amines with Maillard reaction intermediates.

(D) Non-enzymatic photo-oxidative breakdown of residual annatto colorant caused by prolonged fluorescent light exposure.

2008

135. Match the cheese defect in List I with its most probable preventative measure in List II.

List I: (Cheese Defect)

process
(D) Mechanical homogenization of the milk prior to initiating dahi fermentation

2023
183. Which statement accurately reflects the function of bactofugation in cheese making?
(A) It eliminates all vegetative bacterial cells and spores, completely sterilizing the cheese milk
(B) It selectively separates out lactose sugars from the plasma to produce lactose-free cheese
(C) It is a technique used to inject beneficial probiotic bacteria into the solid cheese matrix
(D) It removes 95-98% of anaerobic spores due to their higher density, preventing late blowing

2006
184. When standardizing milk for a specific cheese, if the ratio of Casein to Fat ($\frac{C}{F}$) is too high, the resulting cheese will most likely be:
(A) Hard, dry, and potentially lacking in typical cheese flavor and smoothness
(B) Excessively soft and greasy
(C) Prone to immediate putrefaction
(D) Completely unaffected, as $\frac{C}{F}$ ratio only determines yield, not quality

2022
185. Determine the correct sequence of events during the primary phase of rennet coagulation:
(A) Micelle aggregation → Viscosity increase → Cleavage of kappa-casein → Gelation
(B) Cleavage of kappa-casein → Release of glycomacropeptide → Decrease in steric repulsion → Micelle destabilization
(C) Release of glycomacropeptide → Micelle aggregation → Cleavage of kappa-casein → Gelation
(D) Decrease in steric repulsion → Cleavage of kappa-casein → Micelle destabilization → Release of glycomacropeptide

2018
186. The addition of lysozyme in the manufacture of certain semi-hard cheeses is targeted specifically at preventing:
(A) Early gas production by coliforms
(B) Late gas production by Clostridium
(C) Uncontrolled surface mold growth
(D) Bitter peptide accumulation in curd

2006
187. Processed cheese requires melting a blend of natural cheeses. What is the fundamental role of agitation during the melting process in the cooker?
(A) To ensure uniform heat transfer, break down the cheese mass, and blend components to form a stable emulsion
(B) To rapidly cool the heated mixture down to safe packaging temperatures within the mechanical cooker chamber
(C) To strictly whip substantial volumes of ambient air into the hot product to achieve a light, fluffy texture
(D) To intentionally cause the complete separation of free fat globules from the hydrated casein protein matrix

2016
188. Probiotic bacteria like Lactobacillus acidophilus and Bifidobacterium bifidum are often described as having poor growth characteristics in cow's milk. Which of the following is an effective strategy to improve their viability and growth when manufacturing probiotic dairy products?
(A) Adding broad-spectrum antibiotics to selectively eliminate competitor strains in milk
(B) Increasing incubation temperatures to 65°C to accelerate metabolic reactions in milk
(C) Supplementing milk with growth-promoting substances like yeast extract, peptides, or prebiotics
(D) Lowering milk pH to an acidic 2.0 using concentrated organic acids prior to inoculation

2015
189. During yoghurt manufacturing, a lower incubation temperature (e.g., 37-40°C instead of 42-45°C) typically results in:
(A) A significantly faster fermentation time coupled with high final lactic acidity
(B) Failure of the starter culture to synthesize any organic acids in the milk
(C) Immediate wheying-off of the curd mass accompanied by severe protein syneresis
(D) A longer fermentation, increased exopolysaccharide production, and a viscous gel

2011
190. What is the main characteristic difference between a "mesophilic" starter culture and a "thermophilic" starter culture?

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(B) Maximizing in-line turbulence to incorporate as much air as possible into the gel
(C) Minimizing shear stress using positive displacement pumps to prevent network damage
(D) Adding substantial volumes of warm water to reduce the apparent viscosity permanently

2015
143. Dahi differs from conventional Western yoghurt primarily in terms of:
(A) The raw milk source, which strictly requires pure sheep milk rather than bovine milk
(B) Using undefined mesophilic lactic cultures rather than defined thermophilic symbionts
(C) The total lack of any starter culture inoculation steps in modern commercial settings
(D) The compulsory addition of active calf rennet to induce curd formation and syneresis

2007
144. In cheese manufacture, the term "bactofugation" refers to:
(A) The destruction of vegetative bacteria by exposing flowing milk to intensive ultraviolet light
(B) The intentional inoculation of targeted bacteriophages to kill specific spoilage bacteria
(C) The thermal lysis of bacterial cells using extremely high-pressure plate heat exchangers
(D) Centrifugal separation of bacteria and spores from milk using high-speed centrifuges

2014
145. Determine the correct sequence for evaluating a potential probiotic strain for commercial dairy use:
(A) Acid/bile tolerance testing → Clinical health trials → In-vitro adhesion assays → Strain identification
(B) Strain identification → Acid/bile tolerance testing → In-vitro adhesion assays → Clinical health trials
(C) Clinical health trials → Strain identification → In-vitro adhesion assays → Acid/bile tolerance testing
(D) In-vitro adhesion assays → Clinical health trials → Acid/bile tolerance testing → Strain identification

2023
146. Which of the following is an advantage of utilizing ultrafiltration (UF) in cheese making (e.g., liquid pre-cheese concept)?
(A) Complete elimination of the requirement for active rennet enzymes
(B) Significant reduction in cheese yield due to the loss of whey proteins
(C) Incorporation of whey proteins to increase yield and nutritional value
(D) Drastic acceleration of lipid lipolysis and flavor development rates

2003
147. A "blind" Swiss cheese (Emmental) is one that:
(A) Lacks eye formation due to failure of propionic acid fermentation
(B) Has developed an excessively dark color from intensive browning
(C) Contains massive, irregular mechanical splits and deep physical cracks
(D) Has been heavily contaminated on the rind with wild surface molds

2011
148. The biochemical phenomenon known as the "Hofmeister series" or lyotropic series is often referenced in processed cheese chemistry. Which of the following ions, introduced by emulsifying salts, plays the strongest role in peptizing casein?
(A) Calcium (Ca^{2+})
(B) Magnesium (Mg^{2+})
(C) Iron (Fe^{3+})
(D) Sodium (Na^{+})

NODIA

2013
149. Why is the control of cooling rate critically important for large 20 kg blocks of Cheddar cheese after pressing?
(A) Fast cooling causes the cheese block to shatter internally due to thermal shock
(B) Slow cooling permits ongoing acid production, dropping pH too low and causing sourness
(C) Slow cooling strictly halts all enzymatic activity and prevents ripening proteolysis
(D) Cooling rate has no effect on final quality as long as the block is vacuum sealed

2009
150. Cheese yield is an important economic factor. Which formula is most widely used by the dairy industry to predict the yield of Cheddar cheese based on milk composition?
(A) The Stokes equation
(B) The Arrhenius equation
(C) The Van Slyke and Price formula

the milk
(C) Remove a calculated amount of fat or add skim milk
(D) Homogenize the raw milk under highly elevated pressure

2005
167. Which of the following analytical techniques is most widely used in the dairy industry to monitor the rate and extent of primary proteolysis during cheese ripening?
(A) Gas chromatography to determine volatile free fatty acids
(B) Refractive index analysis using digital dairy refractometry
(C) Spectrophotometric determination of diacetyl concentration
(D) Measuring the nitrogen soluble in pH 4.6 acetate buffer

2009
168. To evaluate the extent of secondary proteolysis (i.e., formation of small peptides and free amino acids) in cheese, which solvent or precipitant is commonly used?
(A) Trichloroacetic acid or phosphotungstic acid
(B) Analytical-grade non-polar hexane solvent
(C) Pure one hundred percent anhydrous ethanol
(D) Analytical-grade chlorinated chloroform

2019
169. What is the principle cause of the "slit" defect occasionally observed in Cheddar cheese?
(A) The use of dull, damaged cutting knives during curd slicing in the vat
(B) Gas production by heterofermentative non-starter lactic acid bacteria
(C) Uncontrolled fluctuations in storage temperature causing deep thermal cracks
(D) The excessive, prolonged application of physical pressure in the press

2009
170. Which of the following enzymes is responsible for the generation of volatile free fatty acids (like butyric, caproic, and caprylic acids) that give strong Italian cheeses their distinct piquancy?
(A) Beta-galactosidase
(B) Pregastric esterase
(C) Aminopeptidase
(D) Plasmin

2015
171. In enzyme biotechnology, the term "immobilization" can be achieved by several techniques. Which of the following is NOT a standard method of enzyme immobilization?
(A) Complete denaturation by intense boiling
(B) Covalent binding to a solid support
(C) Entrapment within a polymer gel (e.g., alginate)
(D) Cross-linking with multifunctional reagents like glutaraldehyde

2021
172. When formulating lactose-free milk using lactase, the process can be performed via batch (in-tank) or aseptic inline dosing. What is the primary disadvantage of the batch (in-tank) process prior to pasteurization?
(A) The enzyme causes fluid milk proteins to coagulate and curdle almost instantly
(B) The enzyme reverse-synthesizes massive amounts of lactose instead of breaking it down
(C) The enzyme is denatured during pasteurization, preventing recovery and raising costs
(D) The biological conversion process strictly requires an incubation of forty-eight hours

2022
173. Bioactive peptides with antimicrobial properties derived from milk proteins typically share which structural characteristics?
(A) They are highly negatively charged, acidic, and purely hydrophilic in nature
(B) They are massive globular macromolecular structures exceeding 100 kDa in weight
(C) They consist almost exclusively of hydrophobic branched-chain amino acids
(D) They are small, positively charged, and amphipathic, allowing membrane disruption

2007
174. Which of the following statements about lactase (beta-galactosidase) is correct?
(A) It strictly and selectively hydrolyzes alpha-1,4-glycosidic bonds in sugars
(B) It requires high temperatures above 80 degrees Celsius to show any activity
(C) It catalyzes both hydrolytic reactions and transgalactosylation reactions
(D) It is an endogenous enzyme present in massive concentrations in raw milk

2002
175. Match the cheese characteristic or defect in List I with its primary biochemical cause in List II.
List I: (Characteristic/Defect)

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2006

159. When comparing direct vat set (DVS) cultures to traditional bulk starter systems, what is the primary operational advantage of DVS?
(A) DVS requires extensive daily propagation and aseptic sub-culturing steps
(B) DVS reduces phage infection risk by eliminating bulk culture preparation steps
(C) DVS cultures possess an infinite storage shelf life at room temperature
(D) DVS cultures are completely immune to all therapeutic milk antibiotics

2015

160. What is the defining characteristic of a "smear-ripened" cheese, such as Limburger or Münster?
(A) It is ripened entirely underwater in a highly saturated salt solution for months
(B) It is deeply injected with viable Penicillium roqueforti spores during curd hooping
(C) It is dipped in liquid wood smoke solutions prior to final mechanical pressing
(D) It undergoes surface washings with Brevibacterium linens, producing a red-orange rind

2023

161. Which structural component of the casein micelle is primarily responsible for its steric stabilization in normal milk, preventing spontaneous aggregation?
(A) The protruding hydrophilic, negatively charged region of kappa-casein
(B) The hydrophobic structural core region of internal beta-casein molecules
(C) The colloidal calcium phosphate nanoclusters within the protein matrix
(D) The bound water molecules trapped deep inside the micelle structure

2001

162. How does the addition of sodium chloride (salting) during cheese manufacture affect the starter bacteria?
(A) It accelerates their metabolic growth rate and acid production kinetics
(B) It causes cell lysis and release of intracellular enzymes within minutes
(C) It slows further acid production, controls moisture, and dictates final pH
(D) It forces starter bacteria to metabolize fat molecules instead of lactose

2011

163. Which method is most effective for extending the shelf life of Cottage cheese, given its high moisture and relatively high pH?
(A) Strict hygiene during curd washing and cold chain maintenance below 4°C
(B) Subjecting the cheese curd to severe high hydrostatic pressure treatment
(C) Storing the finished curd directly in a saturated sodium chloride brine
(D) Drying the wet cheese curd pieces using an industrial tunnel dehydrator

2019

164. In recombinant DNA technology applied to dairy cultures, what is the function of a "promoter" region in a plasmid vector?
(A) To destroy invading bacteriophage genomes inside the cell
(B) To actively transport plasmids out of host bacterial cells
(C) To provide selection marker resistance to ampicillin drugs
(D) To direct and initiate the transcription of the target gene

2015

165. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): The use of unpasteurized (raw) milk for producing cheeses ripened for less than 60 days is generally banned or heavily restricted by modern food safety authorities.
Reason (R): Cheeses ripened for shorter durations at low acidity and high moisture do not provide a sufficiently hostile environment to guarantee the die-off of dangerous pathogens like Listeria monocytogenes and Salmonella.
(A) Both (A) and (R) are true and (R) is the correct explanation of (A).
(B) Both (A) and (R) are true but (R) is not the correct explanation of (A).
(C) (A) is true but (R) is false.
(D) (A) is false but (R) is true.

2001

166. A cheese milk standardization process aims to achieve a specific C/F (casein-to-fat) ratio. If the natural milk has a C/F ratio of 0.65 and the target for Cheddar is 0.70, what action must the operator take?
(A) Add a calculated volume of extra cream to the milk
(B) Add a standardized amount of pure water to

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(D) The Michaelis-Menten equation

2006

151. According to the Van Slyke and Price formula for Cheddar cheese yield, what is the standard fat recovery factor typically achieved in an efficient cheese making operation?
(A) 50%
(B) 75%
(C) 93%
(D) 100%

2018

152. Which sensory attribute is most commonly utilized to ascertain the end of the cheddaring process before milling?
(A) The curd takes on the texture of cooked chicken breast, showing fibrous alignment
(B) The curd tastes distinctly sweet and completely lacks any measurable lactic acidity
(C) The curd undergoes collapse and becomes completely liquid and highly flowable
(D) The curd turns deep yellow independently of any added synthetic coloring agents

2013

153. What is the fundamental role of Leuconostoc mesenteroides in the manufacture of Roquefort or Blue cheese?
(A) It metabolizes lactic acid to produce propionic and acetic acids, which are critical for eye formation
(B) It produces carbon dioxide to open the texture, creating oxygen channels for Penicillium roqueforti growth
(C) It forms a thick, protective dehydration rind on the outer surface of the ripened cheese block
(D) It biochemically induces heavy lipolysis to generate volatile free fatty acids during ripening

2012

154. What is the primary cause of "sandiness" in certain aged cheeses, such as old Gouda or Parmesan?
(A) The precipitation of undissolved sodium chloride table salt in the cheese body
(B) The crystallization of calcium lactate or tyrosine during extended ripening
(C) Contamination with fine silica mineral particles during the curd milling step
(D) The excessive growth of gritty, spore-forming surface mold species on the rind

2007

155. Arrange the following cheeses in increasing order of their typical final moisture content (from lowest moisture to highest moisture):
I. Cheddar
II. Parmesan
III. Cottage Cheese
IV. Gouda
Which of the following sequences represents the correct order?
(A) II, I, IV, III
(B) I, II, IV, III
(C) II, IV, I, III
(D) IV, I, II, III

2014

156. In the context of dairy starters, what is a "phage inhibitory medium" (PIM)?
(A) A growth medium designed specifically to encourage the rapid proliferation of bacteriophages
(B) A food-grade chemical sanitizing spray used to eradicate active phage particles from cheese vats
(C) A medium containing chelating agents to bind calcium, which is required for phage replication
(D) A genetically engineered starter culture strain that produces intracellular phage-blocking proteins

2009

157. Which type of enzyme is strictly required to degrade intact casein into small peptides and free amino acids, preventing the accumulation of bitter peptides during cheese ripening?
(A) Endopeptidases
(B) Lipases
(C) Glycosidases
(D) Exopeptidases

2014

158. Which of the following is an INCORRECT statement regarding the use of prebiotics in dairy?
(A) Prebiotics are non-digestible by human intestinal enzymes.
(B) Prebiotics selectively stimulate the growth or activity of beneficial bacteria in the colon.
(C) Prebiotics are live microbial strains that enhance digestion.
(D) Inulin and fructooligosaccharides (FOS) are widely used prebiotics in dairy.

NODIA

P. Pungent pepper flavor in Provolone
Q. Bitterness in Cheddar
R. Eyes in Swiss cheese
S. Soft, flowing interior of Camembert

List II: (Biochemical Cause)

1. Propionic acid fermentation
2. High concentration of hydrophobic peptides
3. Migration of pH gradient and proteolysis by surface molds
4. Extensive hydrolysis of triglycerides by added lipases

(A) P-4, Q-2, R-1, S-3
(B) P-2, Q-4, R-1, S-3
(C) P-4, Q-1, R-2, S-3
(D) P-1, Q-4, R-3, S-2

2013

176. Which type of bioreactor is most commonly utilized for the industrial continuous hydrolysis of lactose in whey using immobilized enzymes?
(A) Stirred tank batch reactor
(B) Fluidized bed fermenter
(C) Airlift bioreactor
(D) Packed bed reactor

2014

177. ACE-inhibitory peptides are well-studied for their antihypertensive effects. By what mechanism do they lower blood pressure?
(A) They inhibit Angiotensin-Converting Enzyme, preventing vasoconstrictor synthesis and brain-derived peptide breakdown.
(B) They function as powerful physiological diuretics, rapidly flushing excess water and sodium from the body.
(C) They block L-type calcium channels specifically within cardiac muscle tissues to reduce arterial tension.
(D) They physically bind dietary cholesterol molecules in the intestinal lumen, completely preventing absorption.

2017

178. Why is Natamycin highly preferred over sorbates for the surface treatment of ripened cheeses?
(A) Natamycin penetrates deeply into the solid cheese block to destroy internal pathogens
(B) Natamycin imparts an aesthetically pleasing, highly desirable yellow coloration to the rind
(C) Natamycin inhibits molds and yeasts without affecting bacterial starters or ripening bacteria
(D) Natamycin accelerates the metabolic glycolysis pathway, speeding up lactic acid production

2008

179. In the context of dairy starters, what is the role of the CRISPR-Cas system?
(A) A bacterial adaptive immune system providing sequence-specific protection against invading bacteriophages
(B) A recombinant method utilized to rapidly and significantly increase the total fat content of raw milk
(C) A food-grade chemical additive incorporated into cheese milk to prevent the late blowing gas defect
(D) A microbial enzyme that cross-links casein micelles to enhance overall curd firmness and cheese yield

2014

180. Which process step is critical in the manufacture of Cottage cheese to impart its characteristic rich flavor and adjust the final fat content to legal standards (e.g., 4% for regular Cottage cheese)?
(A) The high-pressure physical pressing of the wet curd inside traditional wooden hoops
(B) The addition of active pre-gastric animal lipases during early milk coagulation
(C) The prolonged, slow aging of the salted curd inside natural, highly humid caves
(D) The creaming process, mixing a pasteurized cream dressing with washed, drained curd

2001

181. What defines a "symbiotic" yoghurt starter culture?
(A) A culture system where strains are grown on different substrates prior to inoculation
(B) A culture system where combined growth and acid production exceed the sum of individual rates
(C) A relationship where neither organism can physically grow or survive alone in sterile milk
(D) An interaction where one strain completely dominates and eventually kills the other species

2001

182. A common defect in shrikhand is a sour, highly acidic taste with a grainy texture. What is the most likely cause?
(A) Insufficient addition of sucrose sugar during final mechanical blending
(B) The use of extremely fresh, high-quality sweet bovine milk for processing
(C) Excessive fermentation and high temperatures during the whey draining

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P. Early blowing
Q. Late blowing
R. Bitter flavor
S. Crumbly texture

List II: (Preventative Measure)

1. Proper standardization of salt and balanced starter proteolysis
2. Addition of lysozyme or use of bactofugation
3. Avoiding excessive acid development prior to hooping/pressing
4. Strict hygiene to eliminate coliform contamination in raw milk

(A) P-4, Q-2, R-1, S-3
(B) P-2, Q-4, R-3, S-1
(C) P-4, Q-1, R-2, S-3
(D) P-3, Q-2, R-4, S-1

2025

136. What is the fundamental difference between sweet whey and acid whey derived from cheese making?

(A) Sweet whey is from rennet-coagulated cheeses (pH 6.0-6.5), whereas acid whey is from acid-coagulated cheeses (pH 4.6) with higher mineral content.
(B) Sweet whey contains exclusively lactose sugars in solution, whereas acid whey contains exclusively functional whey proteins with zero carbohydrate fraction.
(C) Sweet whey is intentionally sweetened with refined sucrose during industrial processing, whereas acid whey remains completely unsweetened and sour.
(D) Acid whey retains all original colloidal casein micelles from raw milk within its fluid, whereas sweet whey does not contain any casein fractions.

2001

137. Which minor cheese additive is occasionally employed to accelerate the fading of the natural yellow color of cow's milk when producing sheep/goat-style white cheeses, though its use is restricted?

(A) Calcium chloride
(B) Benzoyl peroxide
(C) Chlorophyll
(D) Sorbic acid

2022

138. The symbiotic fermentation in yoghurt (S. thermophilus and L. bulgaricus) represents which type of microbial relationship during the initial 2-3 hours of incubation?

(A) Commensalism
(B) Mutualism
(C) Amensalism
(D) Parasitism

NODIA

2005

139. Shrikhand is an Indian dairy product prepared from chakka. Which of the following technological interventions is most effective for extending the shelf life of commercially packaged shrikhand?

(A) Thermization of the final shrikhand blend followed by hot packing
(B) Storing the packaged retail product strictly at a temperature of 30°C
(C) Reducing the total sugar concentration to a level below 10% by weight
(D) Adding extremely high doses of active calf rennet during formulation

2001

140. Which of the following statements about probiotic survival in the human gastrointestinal tract is INCORRECT?

(A) Probiotics must survive the highly acidic environment of the stomach (pH 1.5 - 3.0).
(B) Probiotics must tolerate the detergent-like action of bile salts in the duodenum.
(C) Probiotics are exclusively anaerobic and die instantly upon exposure to stomach air bubbles.
(D) The food matrix (e.g., buffering capacity of milk proteins) significantly enhances probiotic survival during gastric transit.

2014

141. Lactic acid bacteria (LAB) are generally fastidious organisms. Which structural component do they critically rely on extracellular proteases to obtain from milk?

(A) Lactose from the milk plasma to supply metabolic energy
(B) Calcium from colloidal phosphates for cell wall rigidity
(C) Short-chain fatty acids released from milk fat globules
(D) Amino acids from casein as they cannot synthesize many of them

2002

142. The "set" in stirred yoghurt must be broken to pump it into containers. What is the most critical rheological parameter that must be managed during this agitation and pumping to avoid destroying the texture?

(A) Heating the yoghurt gel to approximately 60°C during the transfer pumping process

(A) Mesophilic cultures produce only gas; thermophilic cultures produce only acid.
(B) Mesophilic cultures are used exclusively for yoghurt; thermophilic cultures are used exclusively for Cheddar.
(C) Mesophilic cultures have an optimal growth temperature around 25-30°C, while thermophilic cultures thrive at 37-45°C.
(D) Mesophilic cultures strictly require oxygen; thermophilic cultures strictly require absolute anaerobiosis.

2018

191. Which technological advancement has allowed for the automated and continuous production of Cottage cheese curd without the need for delicate handling in large traditional vats?
(A) The use of extreme ultrafiltration to dry the fluid milk instantly
(B) The Hutin-Stenne process using cold-renneting and rapid heating in pipes
(C) The application of high-pressure homogenization to raw cheese milk
(D) The use of scraped surface heat exchangers to freeze the cheese milk

2001

192. Which cheese defect is characterized by a pink/brown discoloration primarily caused by the Maillard reaction during prolonged ripening or storage?
(A) Calcium lactate crystals forming white deposits on the cheese surface
(B) Rust spot defect caused by contamination with Pseudomonas species
(C) Early blowing defect induced by rapid growth of coliform bacteria
(D) Pink defect in cheeses linked to galactose and starter metabolism

2017

193. The enzyme complex "lactase" used commercially to treat dairy products is more precisely identified by which biochemical name?
(A) Beta-galactosidase
(B) Alpha-glucosidase
(C) Lactose dehydrogenase
(D) Galactose mutarotase

2006

194. In the commercial application of immobilized enzymes for lactose hydrolysis, severe microbial contamination of the enzyme reactor is a significant risk. What is a common industrial method to mitigate this without destroying the enzyme?
(A) Boiling the immobilized enzyme reactor system on a daily basis
(B) Adding therapeutic doses of penicillin directly to the milk feed
(C) Operating at low temperatures (4-10°C) with regular, mild sanitation
(D) Operating the biocatalytic reactor at an extremely low pH of 2.0

2019

195. Arrange the following steps in the correct sequence for the commercial isolation and application of a novel bioactive peptide from milk proteins:
I. Enzymatic hydrolysis of the target milk protein
II. In-vivo or clinical trials for efficacy
III. Identification of the target protein sequence
IV. Ultrafiltration and fractionation of the hydrolysate
V. In-vitro testing (e.g., ACE-inhibition assay)
Which of the following sequences represents the correct order?
(A) III, I, IV, V, II
(B) I, III, IV, II, V
(C) III, IV, I, V, II
(D) I, IV, III, V, II

2012

196. The therapeutic benefits of misti dohi and dahi are often attributed to their live lactic acid bacteria. Which term describes the benefit of these bacteria competitively excluding pathogens in the gut?
(A) Nutritional enhancement
(B) Hypercholesterolemia
(C) Immunosuppression
(D) Colonization resistance

2011

197. Which processing factor directly influences the moisture content of the final Cheddar cheese block during the "cooking" stage of the curd?
(A) The concentration and color strength of the annatto dye
(B) The cooking temperature and the duration the curd is held
(C) The specific amount of active calf rennet added to the milk
(D) The physical type of mechanical press used at the end stage

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2017

198. Excessive addition of calcium chloride to cheese milk can lead to which undesirable outcome?
(A) A significantly sweeter, milkier flavor profile in the curd
(B) A heavily delayed coagulation time during initial renneting
(C) A bitter, metallic off-flavor and an overly rigid curd that shatters
(D) Massive, uncontrolled gas production during the pressing stage

2010

199. When manufacturing Gouda cheese, the curd and whey mixture is often heated to roughly 36-38°C by adding hot water. Why is the temperature not raised higher (e.g., to 50°C like in Swiss cheese)?
(A) Higher temperatures would instantly melt fat globules in the curd
(B) Higher temperatures would cause natural annatto color to bleach out
(C) Higher temperatures strictly trigger early and late blowing defects
(D) Gouda's mesophilic starter cultures are inactivated or killed above 40°C

2015

200. In processed cheese formulation, what is the concept of "intact casein"?
(A) Un-degraded casein from raw cheese that provides the structural emulsion framework
(B) Casein fractions that have been completely hydrolyzed into simple free amino acids
(C) Casein proteins that have been covalently cross-linked with high-amylose starch
(D) The specific hydrophilic portion of casein that is lost to the surrounding whey

2021

201. Which specific component of the cheese matrix is attacked by lipases during the ripening of Blue cheese to form methyl ketones, the primary flavor compounds of this cheese?
(A) Lactose
(B) Triglycerides
(C) Casein micelles
(D) Whey proteins

2024

202. The production of traditional shrikhand involves the intermediate step of making chakka. Industrially, the whey drainage step to produce chakka from dahi is typically expedited by using:
(A) Muslin cloth hanging for twenty-four hours
(B) Basket centrifuges or quark separators
(C) Vacuum evaporation of the excess moisture
(D) Reverse osmosis membrane filtration systems

2017

203. Which of the following defines the "phage-endolysin" strategy in dairy biotechnology?
(A) Using phage-derived enzymes to selectively lyse and kill pathogens in dairy products
(B) The enzymatic destruction of active starter cultures to stop lactic acid production
(C) The chemical enhancement of bacteriophage replication kinetics inside the cheese vat
(D) A centrifugal technique utilized for standardizing the fat content of raw cheese milk

2019

204. Recombinant DNA technology can be used to construct "food-grade" vectors for starter cultures. A vector is considered strictly "food-grade" if:
(A) It contains multiple functional genes conferring resistance to clinical antibiotics
(B) It is constructed from biocompatible synthetic polymers rather than biological DNA
(C) It uses DNA from food-grade organisms without antibiotic resistance selection markers
(D) It is designed to rapidly and non-selectively destroy bacteria inside the human gut

2013

205. In the context of dairy starter cultures, what is a "mixed-strain" culture?
(A) A starter culture containing exactly two known, defined, and isolated bacterial strains
(B) A starter culture containing both beneficial lactic bacteria and pathogenic viral particles
(C) A genetically engineered single bacterial strain with multiple foreign genes inserted
(D) An undefined complex mixture of different lactic acid bacteria possessing high phage resistance

NODIA

2011

206. Which of the following statements about milk-clotting enzymes is CORRECT?
(A) Fungal coagulants from Endothia parasitica are suited for long ripening due to low proteolysis
(B) Pepsin is preferred over chymosin because it works optimally at a neutral pH of exactly 7.0
(C) Recombinant bovine chymosin ensures consistent coagulation and minimizes non-

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specific proteolysis
(D) Animal rennet is solely composed of pure, isolated bovine chymosin with no traces of pepsin

2005
207. Which defect is likely to occur in yoghurt if it is incubated at an excessively high temperature (e.g., 50°C) and for too long?
(A) The yoghurt will become exceptionally sweet, aromatic, and smooth in texture
(B) Bacterial inhibition leading to a weak body, excessive wheying-off, and acid flavor
(C) The yoghurt will turn bright blue due to sudden bacterial pigment production
(D) The lactose sugars will spontaneously crystallize into large, gritty particles

2022
208. During the preparation of chakka for shrikhand, excessive whey retention leads to which major defect in the final product?
(A) A dry, crumbly, and highly brittle texture in the final blend
(B) Uncontrollable carbon dioxide gas production during storage
(C) Extreme non-enzymatic browning and yellowing of the product
(D) An excessively sour taste, thin consistency, and rapid spoilage

2019
209. Lassi prepared under modern industrial conditions is often pasteurized or sterilized after fermentation and blending. What is the main technical challenge of this post-fermentation heat treatment?
(A) Heat-induced coagulation of caseins at low pH, requiring stabilizers like pectin
(B) The physical explosion of the retail plastic packaging inside the heater system
(C) The chemical conversion of natural lactic acid into toxic, undesirable compounds
(D) The complete loss of all natural sweet flavor notes and volatile aroma compounds

2025
210. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): Microfiltration is increasingly used to physically remove bacteria from milk destined for cheese manufacture without relying on severe heat.
Reason (R): Microfiltration relies on membranes with pore sizes small enough to retain bacteria and spores while allowing the casein micelles, whey proteins, and dissolved components to pass into the permeate.
(A) Both (A) and (R) are true and (R) is the correct explanation of (A).
(B) Both (A) and (R) are true but (R) is not the correct explanation of (A).
(C) (A) is true but (R) is false.
(D) (A) is false but (R) is true.

2004
211. Which group of bioactive peptides derived from milk proteins is known to stimulate the immune system and enhance the phagocytic activity of macrophages?
(A) Immunomodulatory peptides
(B) Casomorphin peptide fragments
(C) ACE-inhibitory peptide group
(D) Casein phosphopeptide chains

2015
212. Casein phosphopeptides (CPPs), formed during the enzymatic digestion of casein, are functional ingredients known for their ability to:
(A) Drastically and rapidly reduce systemic arterial blood pressure in human trials
(B) Directly kill pathogenic Gram-negative bacteria by disrupting outer membranes
(C) Form highly rigid, biodegradable plastic films for food packaging applications
(D) Bind and solubilize minerals like calcium and iron, enhancing human absorption

2007
213. Beta-casomorphins are a group of peptides derived from beta-casein that exhibit which specific type of biological activity?
(A) Potent, broad-spectrum antifungal activity targeting spoilage molds and yeasts
(B) Opioid-like activity, interacting with receptors in the nervous system
(C) Extreme organoleptic sweetness, acting as natural low-calorie sweeteners
(D) Strong competitive inhibition of hepatic cellular cholesterol synthesis

2017
214. Which statement about the bio-preservative nisin is INCORRECT?
(A) It is designated as food additive E234.
(B) It is particularly effective in preventing the outgrowth of Clostridium botulinum spores in processed cheese.
(C) Its effectiveness strictly increases as the pH

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thirty seven and forty five degrees Celsius. There is no standard commercial category of psychrophilic starters operating at ten to fifteen degrees Celsius in cheese manufacturing.

30. (C) They consist of a complex, uncharacterized mixture of strains offering high phage resistance.
Undefined or artisanal starter cultures are composed of a complex, variable, and largely uncharacterized mixture of multiple bacterial strains. Because of this high microbial diversity, these starters exhibit remarkable natural resistance to bacteriophage attacks. If a phage infects one specific strain, other resistant strains within the complex population can continue the acid fermentation process.

31. (B) They possess exactly the same proteolytic specificity as calf chymosin.
Microbial coagulants, primarily sourced from fungi like Rhizomucor miehei, are widely used as vegetarian alternatives to animal rennet. Although they effectively coagulate milk, they do not possess the same high proteolytic specificity as calf chymosin. Their elevated non specific protease activity can lead to excessive protein breakdown, sometimes causing bitter off flavors during cheese ripening.

32. (D) Aspergillus niger or Kluyveromyces lactis
Recombinant chymosin is produced through genetic engineering by inserting the specific bovine gene responsible for chymosin production into host microorganisms. The host production organisms commonly utilized in industrial fermentation include the filamentous fungus Aspergillus niger or the yeast Kluyveromyces lactis. This process yields a highly pure enzyme that is identical to natural animal chymosin.

33. (A) It exhibits highly specific cleavage of kappa-casein with minimal non-specific proteolysis, preventing bitterness.
Recombinant chymosin offers a major advantage over traditional microbial coagulants, especially during the long maturation of hard cheeses. It exhibits exceptional proteolytic specificity, cleaving only the kappa casein micelle stabilizer while causing almost no non specific protein degradation. This high selectivity prevents the accumulation of hydrophobic bitter peptides, ensuring clean flavor profiles.

NODIA

34. (C) The peptide bond between Phenylalanine (105) and Methionine (106) in kappa-casein
During the primary phase of renneting, chymosin acts as a highly specific endopeptidase. It targets and cleaves a single vulnerable peptide bond located between the amino acid residues Phenylalanine one hundred five and Methionine one hundred six of kappa casein. This cleavage releases the hydrophilic glycomacropeptide into the whey, destabilizing the colloid.

35. (B) I, II and IV
Pepsin shows higher sensitivity to variations in pH during milk coagulation than chymosin. Plant based coagulants like Cynara cardunculus extract are widely used in traditional Mediterranean cheeses. Microbial coagulants are actually more heat stable than animal rennet. Recombinant chymosin is structurally and chemically identical to natural bovine chymosin, ensuring consistent performance.

36. (D) The aggregation of para-casein micelles mediated by calcium ions and hydrophobic bonds above 20°C
The secondary phase of rennet coagulation is a non enzymatic physical process that occurs after kappa casein cleavage. Once micelles are destabilized, they begin to aggregate, driven by hydrophobic interactions and the bridging action of calcium ions. This coagulation process requires temperatures above twenty degrees Celsius to form a solid gel network.

37. (B) Acid gelation occurs via colloidal calcium phosphate solubilization and charge reduction as pH drops to 4.6.
Acid induced gelation occurs as the milk pH is gradually lowered toward the isoelectric point of casein, which is pH 4.6. This pH reduction solubilizes colloidal calcium phosphate into the serum and neutralizes negative charges on the micelles, causing them to precipitate. Renneting, however, relies on specific enzymatic cleavage at higher pH levels.

38. (C) A drastic reduction in the steric repulsion and electronegativity of the casein micelles
During the enzymatic phase of coagulation, chymosin cleaves the polar, hydrophilic glycomacropeptide from the surface of kappa casein. The loss of this negatively charged, highly hydrated macropeptide into the whey causes a drastic reduction in both steric repulsion and

2024

223. What is the fundamental technological reason why regular fluid milk does not naturally coagulate at its normal pH (~ 6.7), even when heated to 100°C?

(A) Heating completely and permanently destroys all soluble calcium ions in milk

(B) The kappa-casein layer maintains steric repulsion; cleavage is required to destabilize it

(C) Bovine milk naturally contains powerful active anticoagulants similar to heparin

(D) Lactose molecules form a dense, protective hydration shell around fat globules

2024

224. Which condition must be met for a bacteriocin to be practically useful as a bio-preservative in a fermented dairy product?

(A) It must aggressively kill the starter culture immediately after fermentation

(B) It must be entirely synthetic and chemical in nature, rather than biological

(C) It must actively impart a strong chemical flavor to mask any food spoilage

(D) It must target pathogens without inhibiting starters, remaining pH stable

2006

225. A cheese is formulated with high levels of attenuated starter cultures for accelerated ripening. What exactly prevents these attenuated cells from causing excessive acidification in the vat?

(A) Stressing cells prevents growth and acid production, but leaves ripening enzymes active

(B) They are completely devoid of any active metabolic enzymes due to autoclaving

(C) They are genetically engineered to synthesize and secrete alkaline compounds

(D) They are completely washed away into the whey stream during mechanical drainage

2007

226. What is the primary difference in the metabolic pathway of a homofermentative lactic acid bacterium versus a heterofermentative one?

(A) Homofermentatives produce exclusively gaseous compounds, while heterofermentatives produce only organic acids

(B) Homofermentatives selectively utilize only milk proteins, whereas heterofermentatives utilize only lipid fractions

(C) Homofermentatives produce only lactic acid via glycolysis, while heterofermentatives produce acid, ethanol, and CO_2

(D) Homofermentatives strictly require extreme heat to survive, while heterofermentatives require freezing climates

2007

227. During the mechanical pressing of cheese curd in hoops, the primary objective is to:

(A) Compress the curd into a mass, expel residual whey, and shape the cheese

(B) Crush starter bacteria to release intracellular ripening enzymes

(C) Force dry salt directly into the geometric center of the block

(D) Heat cheese to pasteurization temperatures using mechanical friction

2004

228. Which of the following defines a "surface mold-ripened" cheese?

(A) Cheddar cheese stored in an open room at high temperatures until it naturally spoils

(B) Any natural or processed cheese variety that has been completely sealed in wax

(C) Standard processed cheese slices left completely uncovered and exposed to ambient air

(D) A soft cheese inoculated with Penicillium camemberti, forming white surface mycelium

2021

229. The excessive consumption of unhydrolyzed lactose by a lactose-intolerant individual leads to gastrointestinal distress primarily because:

(A) Lactose crystallizes in the acidic stomach, causing mechanical tissue damage

(B) Lactose draws water into the gut, where bacteria ferment it into gas and acids

(C) Lactose directly attacks and chemically destroys the delicate intestinal villi

(D) Lactose binds all dietary calcium, causing acute, life-threatening hypocalcemia

NODIA

2018

230. Arrange the following critical processing steps of Mozzarella cheese manufacturing in their correct sequential order:

I. Heating and stretching the curd in hot water (Plasticization)

II. Coagulation of standardized milk

III. Acidification of the curd (via starter or direct acid) to pH $\sim 5.2 - 5.4$

IV. Molding and rapid cooling of the stretched

10. (B) Cheddar cheese: Excellent source of water-soluble vitamin C
Cheddar cheese is a highly nutritious fermented food containing high concentrations of proteins, bioavailable calcium, fat soluble vitamins, and bioactive peptides. However, because vitamin C is a highly water soluble compound, almost all of it is lost with the whey during draining, making mature cheddar cheese a very poor source of vitamin C.

11. (A) Reduced cheese yield and elevated levels of endogenous proteases like plasmin
Raw milk containing high somatic cell counts is indicative of mastitis, which alters milk composition and quality. This abnormal milk has increased levels of native heat stable proteases, particularly plasmin, which break down casein before coagulation can occur. Consequently, this causes weak curd formation, poor syneresis, and significantly reduced overall cheese yield.

12. (C) Heat-induced association of beta-lactoglobulin with kappa-casein
Applying severe heat treatments to milk induces the denaturation of the serum protein beta lactoglobulin. Once denatured, this whey protein physically interacts with kappa casein on the micelle surface through disulfide exchange. This complex steric hindrance blocks chymosin from accessing and cleaving the specific peptide bonds, severely impairing the primary phase of rennet coagulation.

13. (D) Contamination with coliforms and Enterobacter aerogenes
The early blowing defect in cheese occurs within hours or days of pressing, characterized by gas pockets and off flavors. This rapid gas production is caused by the contamination of raw milk with gas producing coliform bacteria, specifically Escherichia coli and Enterobacter aerogenes, which ferment lactose into carbon dioxide and hydrogen.

14. (C) Heat-stable enzymes produced by psychrotrophs cause flavor and texture defects even after milk pasteurization.
Psychrotrophic bacteria can replicate at refrigeration temperatures during raw milk storage, synthesizing highly heat stable lipases and proteases. Although pasteurization effectively kills the bacterial cells, these robust enzymes remain active in the cheese milk. Over time, they degrade lipids and proteins, leading to serious rancid and bitter off flavors in the final cheese.

15. (A) P-4, Q-3, R-1, S-2
Raw milk quality dictates cheese performance. Psychrotrophic enzymes degrade components post pasteurization. Coliform contamination causes early gas blowing and off flavors. Spores of Clostridium tyrobutyricum survive heat treatment to cause late blowing defects during maturation. Mastitic milk, with high somatic cells, weakens curd structure, causing poor firming and lowering total cheese yield.

16. (D) To regulate the final fat-in-dry-matter content of the cheese
Standardizing raw milk for cheese making ensures consistent product quality and regulatory compliance. By adjusting the ratio of casein to fat in the cheese milk, manufacturers can precisely control and predict the fat in dry matter content of the finished cheese. This adjustment ensures that the final product meets standard legal requirements.

17. (A) Bactofugation
Bactofugation is a specialized centrifugal separation technology used to remove heavy microorganisms, especially bacterial spores, from cheese milk. Since bacterial spores have a higher density than milk plasma and fat, they are forced outward and separated. This physical treatment successfully prevents late blowing without using high heat that denatures proteins.

18. (C) 1.4 to 2.0 micrometers
Microfiltration is an advanced membrane separation technique used to sanitize cheese milk. By passing skim milk through specialized ceramic membranes with a pore size range of 1.4 to 2.0 micrometers, more than ninety nine percent of bacteria and spores are physically retained. This specific pore size allows casein micelles to pass through freely.

19. (A) Thermization is a milder treatment (60-65°C, 15s) to limit psychrotrophs rather than ensure pasteurization-level safety.
Thermization is a mild thermal pre treatment typically involving heating milk to sixty to sixty five degrees Celsius for fifteen seconds. Its primary purpose is to limit the growth of psychrotrophic bacteria during temporary storage

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ANSWERS

1. (B) Moisture on a fat-free basis (MFFB) between 49% and 56%
The classification of cheese varieties depends heavily on their moisture content calculated on a fat free basis. Cheeses with a moisture on a fat free basis ranging from forty nine percent to fifty six percent are categorized as hard cheeses. This specific range ensures the characteristic firm texture and shelf stability typical of this dairy product.

2. (C) 48 percent
According to food safety standards in India, cheddar cheese must meet specific composition criteria to ensure authenticity and quality. A critical regulatory requirement is that this cheese must contain a minimum of forty eight percent milk fat calculated on a dry matter basis. This standard helps maintain the rich texture and characteristic flavor profile.

3. (A) The percentage of moisture calculated on a fat-free basis
The fundamental physical standard used to classify cheeses into distinct structural categories like extra hard, hard, semi hard, and soft is the percentage of moisture calculated on a fat free basis. This method accounts for variations in fat content, providing a reliable measure of the protein matrix hydration which determines cheese texture.

4. (D) Internally mold-ripened
Roquefort is a famous blue cheese produced using sheep milk and inoculated with Penicillium roqueforti spores. During the maturation period, these mold spores grow within the interior of the curd, creating characteristic blue veins and a sharp flavor. Consequently, this variety is classified as an internally mold ripened cheese, which distinguishes it from surface ripened types.

5. (A) Both A and R are true and R is the correct explanation of A.
Indian food labeling regulations dictate that products containing animal derived ingredients must be labeled with a brown symbol to designate them as non vegetarian. Because traditional rennet is harvested directly from the stomach lining of slaughtered young calves, cheese made with this enzyme is classified as non vegetarian under these guidelines.

6. (C) Medium-fat cheese requires an FDB of strictly less than 10%.
Cheese classification based on fat on a dry basis defines specific commercial standards for different fat categories. Skim milk cheese contains a very low fat on dry basis, typically below ten percent. Medium fat cheese is legally defined as having a fat content between ten and thirty percent, not less than ten percent.

7. (D) Potential anticarcinogenic and anti-atherogenic effects
Conjugated linoleic acid is a unique group of positional and geometric isomers of linoleic acid naturally present in dairy fat. This bioactive lipid has been extensively studied for its positive health attributes. Scientific research suggests that regular consumption of this compound may offer significant protection due to its potential anticarcinogenic and anti atherogenic effects.

8. (A) Supplying bioactive peptides with antihypertensive properties
During the extended ripening of hard cheeses like Parmesan, intense proteolysis occurs as casein is broken down by enzymes. This biochemical degradation releases various short chain bioactive peptides into the matrix. Many of these specific peptides function as natural inhibitors of angiotensin converting enzyme, thereby providing documented therapeutic benefits with antihypertensive properties.

9. (B) Most lactose is lost in the whey, and the residual lactose is fermented into lactic acid.
During the cheese making process, the physical separation of curd and whey removes the vast majority of water soluble lactose into the whey stream. Any remaining trace amounts of lactose within the green cheese curd are rapidly and completely fermented into lactic acid by lactic acid starter cultures during the early stages of ripening.

NODIA

mass

Which of the following sequences represents the correct order?

(A) II, III, I, IV
(B) II, I, III, IV
(C) III, II, I, IV
(D) II, III, IV, I

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without ensuring pasteurization level safety. Pasteurization requires higher temperatures to guarantee the destruction of all pathogens.

20. (D) Standardization followed by bactofugation and HTST pasteurization
To manufacture high quality Gouda cheese, standardizing the milk establishes the correct casein to fat ratio for maximum yield. Following this with bactofugation physically removes the anaerobic spores responsible for late blowing. Finally, applying high temperature short time pasteurization ensures complete microbiological safety while maintaining the functional properties of milk proteins.

21. (B) It restores the soluble calcium balance disrupted by processing, thereby enhancing overall coagulation.
Thermal processing and cold storage of milk cause colloidal calcium phosphate to solubilize into the serum phase, hindering rennet coagulation. Adding calcium chloride restores the essential balance of soluble calcium ions. These ions decrease the negative charge on casein micelles and form physical bridges, facilitating aggregation during the secondary phase of coagulation.

22. (C) The seeds of the achiote tree (Bixa orellana)
Annatto is a widely used natural orange red food colorant in the cheese industry, particularly for coloring Cheddar. It is chemically extracted from the outer seed coat of the achiote tree, botanically known as Bixa orellana. The primary pigments responsible for the color are bixin, which is fat soluble, and norbixin, which is water soluble.

23. (B) Benzoyl peroxide
Cow milk naturally contains carotenoid pigments like beta carotene, which impart a yellow hue to cheese. In the production of blue veined cheeses, a bright white background is desired to contrast with the blue green mold veins. Benzoyl peroxide is added to decolorize the beta carotene through oxidation, achieving the required white appearance.

24. (A) Italian pasta-filata varieties such as Provolone and Romano
Pregastric esterases, also referred to as lipases, are traditionally sourced from the oral glands of young ruminants like kids, calves, or lambs. These specialized enzymes are added to cheese milk during the production of Italian pasta filata varieties such as Provolone and Romano. They catalyze selective fat breakdown, producing the characteristic piquant and sharp flavor.

25. (C) I and III
Calcium chloride is added to cheese milk at levels of ten to twenty grams per one hundred liters to enhance coagulation. Annatto dye is extremely stable in the low pH environments of cheese curd and remains bound within the protein matrix. Lipases are not added to Cottage cheese, as it is a fresh, mild cheese.

26. (B) Streptococcus thermophilus
Streptococcus thermophilus is a highly important thermophilic lactic acid bacterium utilized globally in the dairy industry. This species has an optimum growth temperature between thirty seven and forty five degrees Celsius, allowing it to survive the high cooking temperatures of Swiss and Mozzarella cheese making. It drives early lactic acid production and acidification.

27. (A) Metabolism of citrate to produce diacetyl and carbon dioxide for flavor and eye formation
Leuconostoc species are heterofermentative mesophilic lactic acid bacteria commonly included in mixed dairy cultures. Their primary metabolic role is the fermentation of citric acid present in milk. This biochemical pathway produces diacetyl, which provides the characteristic buttery flavor, and carbon dioxide gas, which is responsible for forming the small eyes in Gouda or Edam.

NODIA

28. (C) Free amino acids and peptides
The symbiotic relationship between Streptococcus thermophilus and Lactobacillus delbrueckii subspecies bulgaricus is a classic example of protocooperation. Lactobacillus bulgaricus possesses highly active cell wall bound proteases that hydrolyze milk proteins, releasing free amino acids and peptides. These small nitrogenous compounds are easily absorbed and directly stimulate the early growth and acidification of Streptococcus thermophilus.

29. (D) Psychrophilic starters: 10-15°C
Starter cultures used in dairy fermentations are categorized based on their optimum growth temperatures. Mesophilic cultures thrive between twenty five and thirty degrees Celsius, while thermophilic cultures grow optimally between

of the food becomes highly alkaline (above pH 8.0).
(D) It is a polypeptide produced during fermentation by Lactococcus lactis.

2021
215. What limits the application of free (unencapsulated) exogenous proteases added directly to cheese milk for accelerated ripening?
(A) The added enzymes immediately evaporate into air at normal room temperatures
(B) The active enzyme completely prevents the clotting action of rennet coagulation
(C) The added enzymes turn cheese milk into an unusable, solid plastic block structure
(D) Most enzyme is lost in whey, creating economic waste and ruining it for other uses

2016
216. In the mechanized production of cheese, what is the specific function of a "Salting Belt"?
(A) To apply dry salt to milled curd pieces on a conveyor prior to pressing
(B) To inject liquid brine directly into the geometric core of cheese wheels
(C) To continuously measure overall salt content in final packaged cheese blocks
(D) To sanitize conveying belts using highly concentrated hot salt solutions

2001
217. Which physical condition strictly limits the rate of salt diffusion into a large block of cheese during brining?
(A) The visual natural color intensity of the finished cheese block
(B) Moisture content, temperature, block geometry, and brine concentration
(C) The total concentration of annatto colorant added in cheese milk
(D) The specific engineering design of the vat used for coagulation

2015
218. Mozzarella cheese is typically stored in a slightly acidic brine or water solution. If the storage liquid lacks sufficient calcium, what defect will occur in the Mozzarella?
(A) The cheese will develop massive gas holes due to late bacterial fermentation
(B) Calcium leaches from cheese, making the surface soft, slimy, and dissolvable
(C) The cheese will turn violently pink through non-enzymatic chemical reactions
(D) The cheese will dehydrate and harden into a brittle, glass-like structure

2003
219. During the ripening of Cheddar cheese, the concentration of intact alpha-s1-casein rapidly decreases. Which peptide is uniquely formed by the primary action of chymosin on alpha-s1-casein and is used as an indicator of early proteolysis?
(A) Alpha-s1-I-casein
(B) Para-kappa-casein
(C) Glycomacropeptide
(D) Beta-casomorphin-7

2024
220. The addition of water to the curd/whey mixture during Gouda production decreases the lactose content. If this washing step is omitted, the final cheese will most likely be:
(A) Excessively sweet and sticky with an undesirable flavor
(B) Extremely low in final moisture and physically very hard
(C) Too acidic and crumbly due to excessive acid production
(D) Highly susceptible to early blowing defects from coliforms

2009
221. Which enzymatic application is heavily utilized to valorize (add value to) the millions of tons of cheese whey permeate produced globally?
(A) Addition of active chymosin to precipitate remaining trace proteins
(B) Addition of microbial lipases to biochemically synthesize whey butter
(C) Addition of industrial amylases to convert lactose into stable starch
(D) Lactose hydrolysis using beta-galactosidase to produce sweet syrups

2001
222. When preparing probiotic stirred yoghurt, the probiotic strains (e.g., Bifidobacteria) are typically added:
(A) Directly to the raw bulk milk prior to high-temperature pasteurization
(B) Exclusively after the finished retail yoghurt has been stored for three weeks
(C) Simultaneously with standard starter, or before packaging to maximize viability
(D) Direct inoculation into the separated acid whey stream following syneresis

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electronegativity among the remaining para casein micelles, allowing them to approach and aggregate.

39. (D) Holding the milk at a temperature below 15°C
The primary enzymatic phase of renneting is relatively independent of temperature, allowing chymosin to cleave kappa casein even in cold milk. However, the secondary aggregation phase relies heavily on hydrophobic interactions, which are highly temperature dependent. Holding the cheese milk at temperatures below fifteen degrees Celsius successfully inhibits micelle aggregation while allowing cleavage.

40. (A) I, II and IV
The enzymatic phase of renneting has a temperature coefficient of two, while the secondary physical aggregation phase is highly temperature dependent, with a coefficient exceeding ten. Rennet coagulation preserves colloidal calcium phosphate within the curd matrix. Conversely, acid coagulation solubilizes calcium, causing most of it to be lost in the runoff whey.

41. (B) To drain whey, develop acid, and align protein fibers
Cheddaring is a unique step where curd blocks are stacked, turned, and piled in the cheese vat. This physical process has several critical objectives: it expels residual whey from the curd, provides optimal conditions for starter cultures to continue acid development, and aligns protein fibers under pressure to create a characteristic fibrous texture.

42. (B) The cheese will remain excessively soft, retain too much moisture, and fail to develop typical flavor.
Milling and salting Cheddar curd at an excessively high pH halts active starter culture development too early. As a result, the cheese retains high moisture levels due to insufficient syneresis and maintains a weak, soft body. Additionally, the lack of proper acid development severely impairs the biochemical pathways needed for flavor development.

43. (A) Propionibacterium freudenreichii subsp. shermanii
Propionibacterium freudenreichii subspecies shermanii is the specific bacterium responsible for eye formation in Swiss type cheeses like Emmental. During the warm room ripening phase, this microaerophilic bacterium ferments the lactic acid produced by primary starter cultures, generating volatile acids and carbon dioxide gas which forms the characteristic smooth round eyes.

NODIA

44. (C) Propionic acid, acetic acid, and carbon dioxide gas
The eye formation in Swiss cheese is driven by propionic acid fermentation. In this biochemical pathway, propionibacteria ferment lactic acid to produce three primary products: propionic acid, which imparts a sweet flavor, acetic acid, which adds sharpness, and carbon dioxide gas, which accumulates in the curd matrix to form holes.

45. (A) Both A and R are true and R is the correct explanation of A.
Emmental cheese requires high cooking temperatures ranging from fifty to fifty four degrees Celsius to achieve the correct curd dryness and texture. Because mesophilic starters cannot survive these elevated processing temperatures, thermophilic starter cultures like Streptococcus thermophilus are utilized. These robust organisms survive the cooking phase and drive subsequent lactic fermentation.

46. (C) To remove excess lactose, limiting post-pressing acidity to maintain a final pH around 5.2.
In Gouda cheese making, draining a portion of the whey and replacing it with warm water effectively washes the curd. This dilution step physically removes excess lactose and lactic acid from the curd mixture. By limiting the remaining lactose, it prevents over acidification, maintaining the final pH of the mature cheese around five point two.

47. (B) Plasticization of the acidified curd in hot water, followed by stretching and molding
The defining step in pasta filata cheese manufacture is the thermal plasticization of the curd. Once the curd reaches the correct pH, it is immersed in hot water and mechanically stretched and molded. This unique stretching process aligns the casein fibers, creating the characteristic fibrous, elastic texture and excellent melting properties of Mozzarella.

86. (C) Misti dohi is fermented strictly by mesophilic yeast cultures to produce ethanol.
The commercial formulations of traditional Indian fermented dairy products are strictly regulated for quality. While shrikhand, lassi, and dahi follow defined fat and moisture parameters, misti dohi is not fermented by yeasts to yield ethanol. Instead, it is fermented by lactic acid bacteria like Streptococcus thermophilus to produce lactic acid and a sweet, firm curd.

87. (D) To denature beta-lactoglobulin to interact with kappa-casein, reducing syneresis.
Subjecting yoghurt milk to severe heat treatment is a critical processing step in industrial plants. This high heat denatures the whey protein beta lactoglobulin, causing it to complex with kappa casein on the micelle surface. This interaction increases the water holding capacity of the protein gel, significantly reducing whey syneresis and improving viscosity.

88. (A) ST produces formic acid, pyruvic acid, and carbon dioxide, which stimulate the growth of LB.
The fermentation of yoghurt is driven by a highly coordinated symbiosis between Streptococcus thermophilus and Lactobacillus bulgaricus. In the initial stages, the faster growing Streptococcus thermophilus consumes oxygen and metabolizes lactose, producing formic acid, pyruvic acid, and carbon dioxide. These compounds directly stimulate the growth and proteolytic activity of the more fastidious Lactobacillus species.

89. (B) Set yoghurt is fermented in retail packages, while stirred yoghurt is incubated in bulk and agitated.
The manufacturing process for yoghurt differs based on the physical state of the final product. Set yoghurt is packaged immediately after starter inoculation, allowing fermentation and gel formation to occur directly within the retail container. Conversely, stirred yoghurt is fermented in large bulk tanks, agitated to break the gel, and then packaged.

90. (B) Acetaldehyde
While several volatile organic compounds contribute to the sensory profile of fermented dairy products, acetaldehyde is the primary flavor compound responsible for the characteristic green apple like taste of plain yoghurt. It is synthesized by Lactobacillus bulgaricus from threonine via the action of highly active threonine aldolase enzymes during the fermentation process.

91. (A) Agitating the yoghurt immediately before it reaches its final pH of 4.5
Preventing syneresis in set yoghurt requires establishing a highly stable, continuous protein gel network. This stability is achieved by increasing milk solids, heat treating the milk to denature whey proteins, and using exopolysaccharide producing starters. Agitating the gel while it is forming at pH 4.5 destroys the protein structure, severely worsening syneresis.

92. (C) EPS production by certain strains of starter bacteria.
A ropy or highly viscous texture in yoghurt is a physical trait that can be either beneficial or a defect, depending on the desired product profile. This high viscosity is caused by the synthesis of extracellular polysaccharides, commonly known as EPS, by specific strains of lactic acid bacteria included in the starter blend.

93. (D) It must survive passage through stomach acid and small intestine bile salts to remain active.
According to joint guidelines established by the FAO and WHO, a microbial strain must meet strict physiological requirements to be classified as a probiotic. The strain must be consumed alive and possess the capability to survive gastric acidity and small intestinal bile salts, ensuring it reaches the colon in sufficient numbers to exert health benefits.

94. (C) A synergistic combination of live probiotics and selective prebiotic substrates.
A synbiotic is a highly advanced functional food formulation used to optimize gut health. It is defined as a synergistic combination containing both live probiotic microorganisms and selective prebiotic substrates. The prebiotic component is designed to survive upper gastrointestinal digestion, acting as a selective food source that stimulates the growth of the co-administered probiotics.

95. (A) P-3, Q-2, R-1, S-4
Functional dairy ingredients offer unique physiological benefits. Bifidobacterium animalis is a highly documented probiotic strain that colonizes the human gut. Inulin is a non digestible plant oligosaccharide acting as a prebiotic

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fat droplets. This structural failure leads to the separation of free fat, known as oil off, during heating.

58. (B) The gradual increase in hot melt viscosity due to continuous agitation and protein hydration.
In processed cheese manufacturing, creaming describes a crucial physical phenomenon occurring in the hot melt kettle. As the mixture is continuously agitated under high shear, the hydrated casein proteins form a network that restricts fat movement. This structural development leads to a gradual, controlled increase in the viscosity of the hot cheese melt.

59. (A) Spreads have higher moisture and use short-chain phosphates or citrates for a softer texture.
Cheese spreads are formulated differently than standard processed cheese blocks to achieve a soft, spreadable consistency. Spreads contain higher legal moisture levels and utilize specialized short chain phosphates or sodium citrates. These emulsifying salts promote extensive protein hydration and lower calcium cross linking, ensuring a soft, spreadable product even at refrigeration temperatures.

60. (C) Emulsifying salts are strictly limited to sodium chloride and potassium chloride.
The raw material blend for processed cheese must be carefully balanced with various grades of natural cheese. However, emulsifying salts are not limited to table salts like sodium chloride. Instead, they must include specific calcium chelating agents, such as sodium phosphates and citrates, to successfully hydrate casein and stabilize the fat in water emulsion.

61. (D) The continuous coagulation of milk flowing in channels via cold-renneting.
The Alcurd system represents a major technological advance in continuous cheese manufacturing. It functions by applying the cold renneting principle, where milk is mixed with rennet at low temperatures to complete the primary enzymatic phase without coagulation. The milk is then continuously heated in flow channels, inducing rapid, uniform coagulation.

62. (C) It is an enclosed vat with overlapping agitation zones designed for efficient mechanized curd cutting.
A Double O cheese vat is a highly efficient, enclosed vessel widely used in modern commercial cheese plants. Its unique physical shape, resembling a figure eight, provides two overlapping circular agitation zones. This design ensures highly uniform heat transfer, gentle and effective curd cutting, and balanced stirring, minimizing overall fat and fine losses.

63. (B) The knitting, matting, flow, and inversion of curd blocks on a continuous draining conveyor belt.
Industrial cheddaring machines are designed to automate the labor intensive traditional cheddaring process on a massive scale. These systems utilize a series of continuous, slow moving draining conveyor belts. The machine automates the precise physical knitting, matting, flow, and periodic inversion of curd blocks under controlled temperature conditions to develop the desired texture.

64. (D) It ensures a first-in, first-out flow of blocks, maximizing space and automating loading systems.
Continuous deep channel brining systems represent a significant improvement over traditional static brine tanks. By circulating cheese blocks through deep, structured flow channels, these automated systems guarantee a strict first in, first out product flow. This setup optimizes physical factory space, ensures highly uniform salt absorption, and allows for fully automated loading.

65. (A) I and II
Enclosed mechanized cheese vats provide exceptional microbiological hygiene, protecting the curd from external contaminants and facilitating clean in place protocols. Automated blockformers receive salted curd and apply vacuum to press them into highly uniform, dense blocks. However, mechanized cheese manufacturing systems still require standard starter cultures to drive the essential biochemical fermentation process.

66. (C) The metabolic conversion of residual lactose to lactic acid by starter and non-starter bacteria.
During the early phases of cheese ripening, glycolysis is the primary biochemical pathway driving acid development. This process involves the metabolic fermentation of residual milk lactose into lactic acid, catalyzed by starter and non starter lactic acid bacteria. This continuous

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the milk and prevents premature protein degradation before curd formation. The enzymes remain trapped within the curd matrix and are released slowly during aging, driving highly controlled, efficient flavor development.

105. (B) I and III
Free exogenous enzymes added to cheese milk partition primarily into the serum phase, meaning they are largely lost in the runoff whey. Liposomes are highly effective carrier matrices that can be engineered to release their payload at specific pH or temperatures. However, immobilized enzymes are unsuitable for batch curd production.

106. (B) Proline-rich sequences released by L. helveticus.
Bovine beta casein contains several amino acid sequences that can yield bioactive peptides upon enzymatic hydrolysis. The most well characterized angiotensin converting enzyme inhibitory peptides, specifically Val Pro Pro and Ile Pro Pro, are found within proline rich regions. These active peptides are released via fermentation using highly proteolytic strains of Lactobacillus helveticus.

107. (A) Lowering of elevated systemic blood pressure (antihypertensive action).
Bioactive peptides derived from milk protein hydrolysates offer valuable therapeutic applications in functional foods. Those that exhibit angiotensin converting enzyme inhibitory activity physically block the conversion of angiotensin I to angiotensin II, which is a potent vasoconstrictor. Consequently, consuming these peptides provides an effective antihypertensive effect, lowering elevated blood pressure.

108. (C) Lactoferrin
Lactoferricin is a highly potent, cationic antimicrobial peptide capable of inhibiting diverse pathogenic microorganisms. This specific peptide is synthesized via the enzymatic hydrolysis of lactoferrin, a major iron binding glycoprotein present in milk. When lactoferrin is digested by pepsin under acidic conditions in the stomach, it cleaves to release lactoferricin.

109. (D) Bitter taste development due to exposed hydrophobic residues.
A major challenge in the manufacturing of milk protein hydrolysates is maintaining acceptable sensory quality. When milk proteins are subjected to extensive, unguided enzymatic hydrolysis, the globular protein structures unfold. This breakdown exposes internal hydrophobic amino acids, which remain in the solution. These exposed hydrophobic residues are perceived as highly bitter.

110. (C) To destroy protein epitopes that trigger allergic IgE immune responses in susceptible infants.
Cow milk allergy in infants is triggered by specific peptide sequences called epitopes, which are recognized by immunoglobulin E antibodies. The primary immunological goal of producing hypoallergenic infant formula is to utilize extensive enzymatic hydrolysis to break down these intact protein chains. This deep cleavage completely destroys the allergenic epitopes, preventing immune reactions.

111. (B) Microbial proteases like Alcalase or food-grade lactic extracts.
In industrial biotechnology, producing bioactive peptides from milk proteins requires cost effective and highly efficient enzymatic systems. Manufacturers predominantly utilize robust commercial microbial proteases, such as Alcalase, or food grade lactic acid bacterial extracts. These enzymes possess broad cleavage specificity, allowing them to rapidly hydrolyze casein and whey proteins into small peptides.

112. (D) Glucose and Galactose
Lactose is the primary disaccharide naturally present in bovine milk, consisting of two sugar molecules linked by a glycosidic bond. The commercial enzyme beta galactosidase specifically targets and cleaves this molecular linkage. This enzymatic hydrolysis reaction successfully breaks down one molecule of lactose into its two constituent monosaccharides, which are glucose and galactose.

113. (A) It prevents sandiness defects from lactose crystallization.
In frozen dairy desserts like ice cream, high concentrations of lactose can crystallize during storage, leading to a highly undesirable defect known as sandiness. Hydrolyzing lactose into glucose and galactose solves this issue, as both monosaccharides are much more soluble. This increased solubility successfully prevents lactose

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first few days of cheese pressing. This physical defect is caused by the contamination of cheese milk with active coliform bacteria, particularly Escherichia coli and Enterobacter aerogenes. These microbes ferment residual lactose, releasing large amounts of carbon dioxide and hydrogen gas.

77. (D) Butyric acid, carbon dioxide, and hydrogen gas
Late blowing is a serious structural defect occurring weeks or months into the cheese ripening process. This defect is caused by butyric acid fermentation, where anaerobic Clostridium tyrobutyricum spores survive pasteurization and germinate in the curd. These bacteria ferment lactic acid into butyric acid, carbon dioxide, and hydrogen gas, causing cracks and off flavors.

78. (C) The use of bactofugation or addition of lysozyme/nitrates to the milk
Preventing late blowing in semi hard cheeses like Gouda requires eliminating anaerobic Clostridium spores or inhibiting their germination. Key technological interventions include bactofugation, which physically removes high density spores from cheese milk, and adding bio preservatives like lysozyme or chemical agents like sodium nitrate. These agents prevent spore germination during long term cheese ripening.

79. (B) The accumulation of low-weight hydrophobic peptides from unbalanced proteolysis
Bitter flavor defects in matured Cheddar cheese are directly linked to unbalanced proteolysis during aging. If chymosin or microbial enzymes break down casein rapidly without sufficient peptidase activity, short chain hydrophobic peptides accumulate in the matrix. These specific low molecular weight peptides are perceived as highly bitter, spoiling the sensory profile of the cheese.

80. (A) I, II and III
Calcium lactate crystallization forms white, harmless specks on the surface of mature Cheddar during prolonged storage. Pink discoloration in cheese is often linked to Maillard reactions or chromogenic thermophilic bacteria. Early blowing is effectively managed through strict milking hygiene and correct pasteurization. However, late blowing is caused by anaerobic sporeformers, not coliforms.

81. (B) 0.6%
Traditional Indian dahi is a widely consumed fermented milk product produced by lactic fermentation. To ensure standard quality and prevent adulteration, the Food Safety and Standards Authority of India enforces specific compositional standards. According to these regulations, the minimum allowable titratable acidity for dahi must be zero point six percent expressed as lactic acid.

82. (C) A stirred fermented drink prepared by blending dahi with water and sweeteners.
Lassi is a traditional Indian beverage with a major commercial market. From a dairy processing perspective, it is defined as a stirred fermented dairy drink. It is manufactured by blending dahi with potable water, sweeteners, and sometimes flavorings, followed by industrial homogenization to ensure a smooth, stable suspension with minimal syneresis.

83. (A) Extended heating of sweetened milk prior to inoculation, causing Maillard browning.
Misti dohi is a sweet, fermented milk product traditional to Eastern India. Its characteristic brown color and rich caramel flavor are produced by processing the milk before fermentation. The milk is mixed with sugar and subjected to extended boiling, which concentrates the solids and induces intense Maillard browning and sucrose caramelization reactions.

84. (D) It is the solid mass obtained by draining whey from dahi (strained curd).
Chakka is an essential intermediate base material used to manufacture the popular sweetened dairy dessert shrikhand. It is produced by draining the liquid whey from fermented dahi, traditionally using muslin cloth bags. The remaining concentrated, semi solid mass contains high levels of milk proteins and fat, providing the base structure for shrikhand.

85. (A) Both A and R are true and R is the correct explanation of A.
In the commercial manufacture of chakka, utilizing buffalo milk yields a significantly higher product mass than cow milk. This higher yield is directly attributed to the composition of buffalo milk, which naturally contains higher levels of total solids, particularly casein and fat, which remain trapped inside the curd during the whey draining process.

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acidification is crucial as it lowers pH, controlling microbial spoilage and driving cheese maturation.

67. (A) Proteolysis
Proteolysis is a complex and critical biochemical pathway during cheese maturation. The continuous breakdown of the intact casein matrix into smaller peptides and free amino acids directly results in the physical softening of the cheese body. Furthermore, these proteolysis products act as precursors for various volatile flavor compounds, establishing background taste.

68. (D) Chymosin (retained coagulant)
During the early stages of cheese ripening, the initial proteolytic degradation of alpha s1 casein is primarily driven by chymosin. A significant portion of this added coagulant remains active within the curd matrix after pressing. Chymosin specifically cleaves the Phe23 Glu24 bond of alpha s1 casein, initiating the structural breakdown of the cheese.

69. (B) Beta-casein
Plasmin is a highly heat stable, endogenous alkaline protease naturally present in milk. It survives high cooking temperatures used for Swiss and Italian cheeses, unlike chymosin which is thermally inactivated. Plasmin has a strong substrate preference for beta casein, hydrolyzing it into gamma caseins and proteose peptones, thereby driving mature cheese texture.

70. (C) Blue-veined cheese
In blue veined cheeses like Roquefort or Gorgonzola, extensive lipolysis is a critical biochemical requirement during ripening. The mold Penicillium roqueforti synthesizes highly active extracellular lipases that aggressively hydrolyze milk triglycerides. This reaction releases free fatty acids, which undergo beta oxidation to form methyl ketones, providing the characteristic sharp, peppery flavor.

71. (D) Unbalanced flavor profiles and the rapid proliferation of spoilage or pathogenic microbes.
Elevating the ripening temperature of cheese blocks from eight to fifteen degrees Celsius successfully increases metabolic rates and accelerates maturation. However, this process carries high commercial risks. It often results in highly unbalanced flavor profiles due to excessive non specific proteolysis and promotes the rapid, dangerous growth of spoilage microorganisms or pathogens.

72. (A) Treating cells so they cannot produce acid, while keeping their intracellular ripening enzymes active.
In accelerated cheese ripening, attenuation refers to the processing of starter culture cells to render them unable to produce lactic acid while preserving their active intracellular enzymes. These cells are typically attenuated using physical treatments like mild heat or freezing, allowing them to lyse and release peptidases into the cheese curd without over acidifying it.

73. (B) A balanced mixture of microencapsulated proteinases and peptidases.
To accelerate Cheddar ripening without defects, a highly balanced enzyme strategy is required. Adding only proteinases breaks down intact proteins but generates hydrophobic peptides, causing bitterness. Combining proteinases with specific peptidases successfully degrades these bitter peptides into small peptides and amino acids, ensuring rapid texture softening and clean flavor development.

74. (B) It prevents premature protein degradation, trapping enzymes in curd for slow release during aging.
Adding free exogenous enzymes directly to cheese milk is highly inefficient, as most enzymes partition into the aqueous phase and are lost in the whey. Microencapsulating these enzymes within lipid or protein capsules ensures they are physically trapped inside the curd matrix. This technology prevents premature protein degradation and allows slow, controlled release during ripening.

75. (A) I and II
Elevated storage temperatures successfully accelerate cheese ripening but increase the risks of microbial spoilage. Incorporating specific peptidases into the cheese matrix helps degrade hydrophobic bitter peptides, preventing off flavors. Attenuated starters do not contribute to acid production during early coagulation, and exogenous lipases are widely used in pasta filata ripening.

76. (C) Escherichia coli and Enterobacter aerogenes
The early blowing defect manifests as rapid gas production and structure deformation within the

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substrate. Nisin is a natural antimicrobial peptide widely used as a bio preservative. Conjugated linoleic acid is a functional fatty acid with health benefits.

96. (D) Galactooligosaccharides (GOS)
Galactooligosaccharides are highly effective prebiotic compounds widely utilized in infant formula and functional dairy foods. These compounds are naturally synthesized in small quantities by dairy starter cultures like Streptococcus thermophilus. The enzyme beta galactosidase catalyzes a transgalactosylation reaction, linking galactose molecules to form GOS, which selectively stimulates beneficial Bifidobacterium species in the colon.

97. (A) Probiotics die off during cold storage due to low pH and acid accumulation from starters.
The primary challenge of producing probiotic stirred yoghurt is maintaining high cell viability during commercial shelf life. During cold storage, the highly acidic environment of the yoghurt, driven by post acidification from starter cultures, causes the sensitive probiotic cells to die off. This loss of viability prevents the product from delivering therapeutic probiotic levels.

98. (C) Probiotics deconjugate bile salts via BSH, causing serum cholesterol use for new bile acids.
Certain probiotic strains exhibit a clinically relevant cholesterol lowering effect driven by the synthesis of bile salt hydrolase enzymes. This active enzyme deconjugates bile salts within the human small intestine, rendering them insoluble and preventing reabsorption. Consequently, the liver must consume systemic serum cholesterol to synthesize new bile acids, lowering overall blood cholesterol levels.

99. (A) There are severe regulatory hurdles and negative consumer perception regarding food GMOs.
Despite the incredible scientific potential of genetic engineering in dairy biotechnology, genetically modified starter cultures are rarely used in commercial food plants. This lack of use is driven by severe regulatory hurdles established by global food safety authorities and strongly negative consumer perceptions regarding genetically modified organisms in daily food products.

100. (B) I, IV and V
Genetic engineering allows for the introduction of robust plasmid encoded bacteriophage resistance mechanisms in Lactococcus lactis. Industrial researchers can target specific gene clusters to enhance exopolysaccharide production, improving texture. Furthermore, modern CRISPR Cas genome editing can successfully immunize starter bacteria against lytic phages. However, genetically modified starters are banned in many commercial regions.

101. (B) Resistance to lytic bacteriophages via abortive infection systems.
In commercial dairy fermentations, bacteriophage attacks present the most severe risk of culture failure. To counter this, molecular researchers utilize natural conjugation or genetic engineering to transfer plasmid encoded resistance traits into Lactococcus lactis. These traits often include highly effective abortive infection systems, which halt phage replication and protect the fermentation line.

102. (C) The apparent Michaelis constant (K_m) increases due to mass transfer limits.
Immobilizing dairy enzymes on solid supports introduces physical mass transfer limitations. The substrate molecules must diffuse through a boundary layer to access the bound enzyme active sites. Consequently, this physical resistance causes a noticeable increase in the apparent Michaelis constant, indicating a lower apparent affinity between the enzyme and substrate.

103. (D) The enzyme can be reused continuously without remaining in the final food product.
Using immobilized beta galactosidase reactors in commercial dairy processing offers major economic advantages. Unlike free enzymes added directly to the batch, the immobilized enzyme remains bound to the solid support within the bioreactor. This setup allows the enzyme to be reused continuously for extensive processing volumes, preventing contamination of the final milk.

104. (A) Ensure uniform distribution in milk, prevent early casein breakdown, and release enzymes slowly.
Microencapsulating cheese ripening enzymes within lipid bilayers called liposomes solves major technical challenges. This biotechnology ensures uniform enzyme distribution throughout

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48. (B) 5.1 to 5.4
For Mozzarella cheese to exhibit its optimal stretchability and melting characteristics, the curd must be plasticized within a precise pH range of 5.1 to 5.4. At this pH, colloidal calcium phosphate is partially solubilized, allowing the casein matrix to become flexible, elastic, and highly responsive to mechanical stretching in hot water.

49. (A) It provides uniform salt distribution and forms a firm outer rind.
Brine salting is a highly effective method for salting cheeses like Gouda. Immersion in a concentrated salt solution allows sodium chloride to diffuse slowly and uniformly throughout the cheese block. This slow diffusion helps establish a consistent salt gradient, regulates moisture retention, and promotes the development of a clean, protective outer rind.

50. (C) Gouda requires high-temperature cooking (54°C) like Swiss cheese, whereas Cheddar does not.
While Cheddar relies on the dry salting and cheddaring steps to control moisture and acidity, Gouda utilizes brine salting and a curd washing step. Crucially, Gouda cheese does not undergo the high temperature cooking process of fifty four degrees Celsius typical of Swiss cheeses; its cooking temperature is kept much lower, around thirty eight degrees.

51. (A) Acid-coagulated soft unripened cheese
Cottage cheese is a highly popular dairy product classified as an acid coagulated, soft, unripened cheese variety. It is manufactured from skim milk through slow acid development driven by starter cultures. The resulting curd is washed, drained, and mixed with a salted cream dressing, producing a fresh product meant for immediate consumption.

52. (D) Slow microbial acidification to pH 4.6, often utilizing a trace amount of rennet for curd firmness.
The traditional manufacture of Cottage cheese relies on slow acidification by mesophilic cultures to reach the isoelectric point of casein at pH 4.6. This slow fermentation process is often accompanied by adding a trace amount of rennet, which helps improve curd firmness and structural integrity during subsequent cutting and washing operations.

53. (B) High-speed centrifugal separation using a quark separator
In modern industrial Quark production, the acid coagulated milk is processed continuously to separate the whey from the curd. This separation is achieved using high speed centrifugal separators designed specifically for quark. This mechanical process replaces traditional bag draining, ensuring a highly hygienic, rapid, and efficient separation of whey from the curd.

54. (C) Heat-induced denaturation of whey proteins combined with acidification to their isoelectric points.
Ricotta is a traditional Italian cheese made by heating cheese whey to high temperatures of eighty to ninety degrees Celsius. This severe heating denatures the water soluble whey proteins, particularly beta lactoglobulin and alpha lactalbumin. Adding acid then lowers the pH to their isoelectric points, causing the proteins to coagulate and float to the surface.

55. (A) P-2, Q-4, R-1, S-3
Different cheese varieties possess unique manufacturing pathways. Cheddar requires curd milling and dry salting prior to pressing. Mozzarella is characterized by hot water stretching and plasticization. Ricotta is produced via the heat and acid precipitation of whey proteins. Cottage cheese involves slow lactic acid coagulation to pH 4.6 followed by thorough curd washing.

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56. (A) They sequester calcium from casein, hydrating proteins to form a stable fat-in-water emulsion.
During processed cheese manufacturing, emulsifying salts play an essential biochemical role. These salts, typically sodium citrates or phosphates, sequester calcium ions from the insoluble calcium paracaseinate network. This calcium depletion hydrates the casein, converting it into a highly functional emulsifier that surrounds fat droplets, creating a stable, uniform fat in water emulsion.

57. (B) Separation of free fat and water during heating (oil-off)
In processed cheese making, achieving proper protein hydration and fat emulsification requires sufficient emulsifying salts and heat. If the salt dosage is inadequate or the melt temperature is too low, the casein cannot successfully coat the

crystallization, maintaining a smooth, creamy texture.

114. (C) Resulting glucose and galactose have higher sweetness than lactose.
Ultrafiltration permeate is a major byproduct containing high levels of lactose, which has relatively low sweetness. Enzymatic hydrolysis of this stream converts lactose into glucose and galactose. Because both glucose and galactose possess significantly higher relative sweetness values than lactose, this reaction drastically increases the sweetness, allowing the syrup to be recycled as a sweetener.

115. (A) I, II and IV
Commercial beta galactosidase is sourced from yeasts like Kluyveromyces lactis or molds like Aspergillus oryzae. High lactose concentrations can trigger transgalactosylation, synthesizing prebiotic galactooligosaccharides. Fungal beta galactosidase operates efficiently at acidic pH, making it ideal for acid whey. However, lactose free milk undergoes more Maillard browning due to reactive monosaccharides.

116. (D) Lactococcus lactis subsp. lactis
Nisin is a class one bacteriocin synthesized by certain strains of Lactococcus lactis subspecies lactis during their active growth phase. This ribosomally produced antimicrobial peptide is highly effective at inhibiting a broad range of Gram-positive bacteria. Consequently, this natural preservative has found extensive commercial application in maintaining safety and extending quality shelf life within the global dairy industry.

117. (B) It binds to lipid II, inhibiting cell wall synthesis, and forms pores in the cytoplasmic membrane.
Nisin targets Gram-positive bacteria by binding specifically to lipid two, an essential cell wall precursor molecule. This binding immediately interrupts cell wall synthesis, preventing the bacteria from maintaining structural integrity. Additionally, nisin inserts into the cytoplasmic membrane to form stable pores, causing rapid leakage of crucial cellular components and leading to cell death.

118. (C) Gram-positive bacteria, especially the spore outgrowths of Clostridium and Bacillus species.
Commercial applications of nisin focus primarily on controlling Gram-positive spoilage and pathogenic organisms. It is highly effective at preventing the outgrowth of bacterial spores from genera like Clostridium and Bacillus in processed cheese and other dairy products. This selective activity helps prevent late blowing and structural defects without affecting the sensory attributes of cheese.

119. (D) It is an antifungal agent against yeasts and molds applied as a surface treatment to rinds.
Natamycin is a polyene macrolide antimycotic used in food preservation to inhibit the growth of yeasts and molds. Since it does not affect bacterial starter cultures or ripening bacteria, it is typically applied as a liquid suspension or spray directly onto cheese rinds. This surface treatment successfully prevents environmental mold contamination during cheese ripening.

120. (A) I, II and IV
Pediocin has strong anti-listerial action, and natamycin prevents fungal growth by binding to ergosterol in the cell membrane. Both nisin and natamycin are approved globally as food preservatives within legal limits. Conversely, nisin is ineffective against Gram-negative bacteria without chelating agents and is not used in yoghurt as it would inhibit starter cultures.

121. (B) The presence of high levels of butyric acid
The fermentation of lactic acid by Clostridium tyrobutyricum yields butyric acid, carbon dioxide, and hydrogen gas during the late stages of ripening. The presence of butyric acid, which imparts a sharp, rancid odor, clearly distinguishes late blowing from early blowing. Early blowing is typically caused by coliforms fermenting lactose into lactic acid, carbon dioxide, and hydrogen.

122. (B) Bactofugation or microfiltration of the cheese milk prior to vat processing
Bactofugation and microfiltration are highly effective physical separation methods used to remove bacterial spores from cheese milk before cheese making begins. Because spores of Clostridium tyrobutyricum have a higher density than milk, centrifugal separation or size-exclusion membrane filtration can eliminate them. This prevents late blowing without

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requiring chemicals or additives that may be legally restricted.

123. (B) Be halved
The enzymatic phase of milk coagulation depends directly on the concentration of the clotting enzyme. According to the classical principles of enzymatic kinetics in cheese making, the primary coagulation time is inversely proportional to the rennet concentration. Therefore, doubling the rennet dosage under identical environmental conditions will theoretically cut the overall primary coagulation time in half.

124. (C) Decreasing the mechanical agitation of the curd
Syneresis, or the expulsion of whey from the curd, is driven by the contraction of the casein gel network. This physical process is accelerated by cutting the curd into smaller pieces, increasing the cooking temperature, and raising the rate of acid development. Decreasing mechanical agitation slows down whey expulsion, whereas active stirring promotes moisture release.

125. (A) Both (A) and (R) are true and (R) is the correct explanation of (A).
Homogenization of milk is avoided in making traditional hard cheeses because it reduces fat globule size and covers them with casein. This alteration prevents the proper formation of a continuous, strong casein matrix during renneting. The resulting weak curd limits syneresis, yielding cheese with high moisture, a crumbly texture, and poor physical structure.

126. (C) Washing the curd to raise pH and increase moisture content
Low-fat cheeses often develop an undesirable rubbery or firm texture due to a high density of the casein matrix. Washing the curd with water removes lactose, which slows down acid production and raises the pH. This process increases moisture retention within the cheese protein network, successfully mimicking the soft texture of full-fat cheese varieties.

127. (B) Coagulation → Cutting → Cooking → Cheddaring → Milling → Salting → Pressing
The production of Cheddar cheese follows a precise sequence of technical operations. First, milk undergoes coagulation to form a gel, which is cut to initiate whey separation. The curd is then cooked to promote syneresis, followed by cheddaring to develop texture. Finally, the blocks are milled, dry-salted, and pressed into their final solid shape.

128. (D) Acid-coagulated curd loses its colloidal calcium phosphate via solubilization at low pH; rennet curd retains it within the casein matrix.
In acid-coagulated cheeses, the low pH solubilizes colloidal calcium phosphate, causing calcium ions to migrate out of the casein micelles and into the whey. Conversely, rennet-coagulated cheeses are formed at a higher pH, allowing the casein matrix to retain most of its colloidal calcium phosphate. This retention provides structural rigidity and elastic properties to the cheese.

129. (A) The flora metabolizes lactic acid and produces ammonia, raising the pH and causing inward calcium migration and core softening.
During the ripening of Camembert, the surface mold Penicillium camemberti metabolizes lactic acid, reducing acidity. The mold also deaminates amino acids, producing ammonia which diffuses inward. This raises the cheese pH toward neutral, triggering the migration of calcium ions toward the surface. Consequently, the casein matrix destabilizes, causing the characteristic softening of the interior.

130. (C) Lactose concentration
Calf chymosin is a proteolytic enzyme whose milk-clotting activity is highly dependent on environmental and physical factors. Temperature, pH, and the concentration of soluble calcium ions directly influence both the enzymatic cleavage of kappa-casein and the subsequent aggregation of destabilized micelles. However, lactose concentration does not play a direct role in this enzymatic coagulation process.

131. (A) The cheese will exhibit a crumbly, mealy texture as proteins approach their isoelectric point and lose emulsifying capacity.
In processed cheese manufacture, a pH below five point two causes proteins to approach their isoelectric point. At this low pH, the net charge on casein molecules is minimized, reducing their water-binding capacity and ability to emulsify fat. This protein destabilization prevents the formation of a smooth, cohesive structure, leading to a mealy, crumbly defect.

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132. (D) It sequester calcium and promotes firm protein cross-linking, resulting in a stable, sliceable texture.
Sodium hexametaphosphate is a long-chain polyphosphate that acts as an effective emulsifying salt in processed cheese. It works by sequestering calcium from the casein micelles, allowing the proteins to hydrate and act as emulsifiers. During cooling, it promotes strong protein cross-linking, resulting in a firm, sliceable texture suitable for cheese slices.

133. (B) Partial demineralization of the casein network at pH 5.2-5.4, followed by mechanical stretching in hot water.
The characteristic fibrous structure of pasta-filata cheeses requires partial demineralization of the casein network. Acidification of the curd to a pH between five point two and five point four removes some colloidal calcium phosphate. This specific mineral loss allows the casein micelles to align into parallel fibers under the mechanical influence of stretching in hot water.

134. (C) Reactions involving amino acid oxidation or interactions of specific amines with Maillard reaction intermediates.
Pinking is a biochemical defect in Italian-type hard cheeses linked to complex interactions of nitrogenous compounds. It occurs during extended ripening when specific free amino acids or amines react with intermediates of the Maillard reaction. This reaction forms pink or reddish pigments that disfigure the interior of cheeses like Parmesan and Romano.

135. (A) P-4, Q-2, R-1, S-3
Proper hygiene eliminates coliforms, preventing early blowing in cheese. Late blowing is controlled by using lysozyme or bactofugation to destroy anaerobic spores. Bitter flavors are avoided by balancing starter proteolysis and salt levels, while crumbly textures are prevented by avoiding excessive acid development prior to pressing. These interventions ensure overall product quality.

136. (A) Sweet whey is from rennet-coagulated cheeses (pH 6.0-6.5), whereas acid whey is from acid-coagulated cheeses (pH 4.6) with higher mineral content.
Sweet whey is produced as a byproduct of rennet-coagulated cheese manufacture at a neutral to slightly acidic pH. Conversely, acid whey is derived from acid-coagulated dairy products at a much lower pH of approximately four point six. Because of the low pH, acid whey contains substantially higher amounts of solubilized minerals.

137. (B) Benzoyl peroxide
Benzoyl peroxide is a bleaching agent occasionally utilized in the dairy industry to oxidize carotenoid pigments in cow's milk. This treatment fades the natural yellow color of cow's milk, making the finished cheese white, which resembles traditional sheep or goat cheeses. However, regulatory standards restrict its application in many countries.

138. (B) Mutualism
The initial fermentation phase in yoghurt manufacture involves a mutualistic relationship between Streptococcus thermophilus and Lactobacillus bulgaricus. Streptococcus thermophilus grows first, producing formic acid and carbon dioxide that stimulate Lactobacillus bulgaricus. In turn, the lactobacillus degrades milk proteins into peptides and amino acids, stimulating the streptococcus. This mutual stimulation accelerates overall acid production.

139. (A) Thermization of the final shrikhand blend followed by hot packing
To extend the shelf life of commercially packaged shrikhand, manufacturers apply a mild heat treatment known as thermization to the final blend. This thermal process inactivates residual starter cultures and destroys potential yeast and mold contaminants. Packaging the warm product immediately after thermization prevents recontamination, ensuring a longer shelf life under refrigeration.

140. (C) Probiotics are exclusively anaerobic and die instantly upon exposure to stomach air bubbles.
Probiotic bacteria are not exclusively anaerobic; many strains are aerotolerant anaerobes or microaerophiles that do not die upon brief exposure to oxygen. To be effective, probiotics must survive the acidic conditions of the stomach and resist duodenal bile salts. Additionally, the milk protein matrix provides physical protection and buffering capacity during gastric passage.

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141. (D) Amino acids from casein as they cannot synthesize many of them
Lactic acid bacteria are highly fastidious micro-organisms that lack the biosynthetic pathways required to synthesize several essential amino acids. To grow in milk, they must rely on their cell wall-bound extracellular proteases to hydrolyze intact casein proteins. This enzymatic cleavage produces small peptides and free amino acids that the bacteria can transport and utilize.

142. (C) Minimizing shear stress using positive displacement pumps to prevent network damage
During the processing of stirred yoghurt, the acid gel network is highly sensitive to permanent structural damage. Subjecting the gel to excessive shear stress during pumping and agitation ruptures the protein matrix, leading to wheying-off and loss of viscosity. Minimizing shear stress by utilizing gentle positive displacement pumps preserves the smooth texture.

143. (B) Using undefined mesophilic lactic cultures rather than defined thermophilic symbionts
Dahi is traditionally prepared using undefined, mixed mesophilic starter cultures, including Lactococcus lactis and Leuconostoc species. These micro-organisms grow optimally at lower temperatures of twenty-five to thirty degrees Celsius. This biological formulation differs significantly from Western style yoghurt, which strictly relies on a defined symbiotic combination of thermophilic starter cultures.

144. (D) Centrifugal separation of bacteria and spores from milk using high-speed centrifuges
Bactofugation is a specialized centrifugal separation technology used in the dairy industry to remove micro-organisms and bacterial spores from milk. Since bacterial cells and dense spores possess a higher specific density than milk plasma, high-speed centrifuges can continuously separate them. This mechanical process helps prevent late blowing defects during cheese ripening.

145. (B) Strain identification → Acid/bile tolerance testing → In-vitro adhesion assays → Clinical health trials
Evaluating a potential probiotic strain follows a systematic, hierarchical testing regime. The process starts with precise taxonomic strain identification, followed by in-vitro screening for stomach acid and bile tolerance. Promising candidates then undergo in-vitro cell adhesion assays to verify intestinal colonization capacity before validating health benefits in human clinical trials.

146. (C) Incorporation of whey proteins to increase yield and nutritional value
Using ultrafiltration to concentrate cheese milk allows whey proteins to be retained within the retentate instead of being lost in the whey. During coagulation, these highly nutritional proteins become entrapped in the casein matrix. This incorporation significantly increases the total cheese yield and enhances the overall protein quality of the product.

147. (A) Lacks eye formation due to failure of propionic acid fermentation
A blind Swiss-type cheese is a structural defect characterized by the absence of eye formation. This issue occurs when Propionibacterium freudenreichii fails to ferment lactic acid into propionic acid, acetic acid, and carbon dioxide. Without sufficient carbon dioxide gas production and proper accumulation, the characteristic gas pockets cannot open in the cheese.

148. (D) Sodium (Na^+)
In processed cheese chemistry, the peptization of casein proteins is heavily influenced by the ionic species present. According to the Hofmeister series, monovalent sodium ions from emulsifying salts play a strong role in replacing calcium within the casein matrix. This ion exchange hydrates and solubilizes the protein network, promoting stable fat emulsification.

149. (B) Slow cooling permits ongoing acid production, dropping pH too low and causing sourness
Controlling the cooling rate of large Cheddar cheese blocks is vital after pressing. If cooled too slowly, the warm interior temperature allows residual starter bacteria to continue fermenting lactose. This ongoing fermentation drives the pH down to undesirable levels, yielding an overly sour taste, brittle body, and serious structural defects in the final cheese.

150. (C) The Van Slyke and Price formula
The Van Slyke and Price formula is the standard mathematical model used in the dairy industry to predict Cheddar cheese yield. This equation calculates predicted cheese yield based on the fat and casein content of the milk, adjusted for moisture retention and salt. It helps cheesemakers

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evaluate production efficiency and optimize processing variables.

151. (C) 93%
In the Van Slyke and Price formula, the fat recovery factor represents the percentage of milk fat successfully retained in the cheese curd. In highly efficient, modern Cheddar cheese manufacturing plants, this recovery factor is typically set at ninety-three percent. The remaining seven percent is lost to the whey stream during curd cutting and syneresis.

152. (A) The curd takes on the texture of cooked chicken breast, showing fibrous alignment
Cheddaring is a traditional step designed to develop a distinct texture in the cheese curd blocks. During this stacking and turning process, lactic acid builds up, altering the casein protein network. Cheesemakers determine the end of cheddaring when the curd takes on a fibrous structure similar to cooked chicken breast, showing clear alignment.

153. (B) It produces carbon dioxide to open the texture, creating oxygen channels for Penicillium roqueforti growth
Leuconostoc mesenteroides is a heterofermentative bacterium utilized in blue cheese production to ferment residual citrate. This metabolic pathway produces carbon dioxide gas, which expands and creates mechanical openings within the curd structure. These open spaces provide the necessary oxygen channels required for Penicillium roqueforti spores to germinate and grow internally.

154. (B) The crystallization of calcium lactate or tyrosine during extended ripening
Sandiness in aged hard cheeses like old Gouda or Parmesan is caused by the precipitation of insoluble crystals. During extended ripening, intensive proteolysis increases free tyrosine concentrations, leading directly to crystallization. Similarly, high concentrations of lactic acid and calcium ions cause calcium lactate to crystallize, creating a distinct, sandy mouthfeel.

155. (A) II, I, IV, III
The classification of cheese varieties depends heavily on their final moisture content. Parmesan is a very hard cheese with the lowest moisture level. Cheddar is a hard cheese with intermediate moisture, followed closely by Gouda, which is a semi-hard cheese. Cottage cheese is unripened and has the highest moisture content.

156. (C) A medium containing chelating agents to bind calcium, which is required for phage replication
A phage inhibitory medium is a specialized growth medium used to propagate starter cultures safely. It contains food-grade chelating agents, such as phosphates, which bind calcium ions in the medium. Because bacteriophages strictly require calcium for host cell attachment and injection of genetic material, removing calcium successfully prevents phage replication.

157. (D) Exopeptidases
During cheese ripening, endopeptidases cleave internal peptide bonds of caseins, producing hydrophobic peptides that often cause bitterness. To prevent this defect, exopeptidases are required to hydrolyze terminal amino acids from these bitter peptides. This process yields short, non-bitter peptides and free amino acids, enhancing the overall flavor and complexity of the cheese.

158. (C) Prebiotics are live microbial strains that enhance digestion.
Prebiotics are non-viable chemical compounds, primarily oligosaccharides like inulin and fructooligosaccharides, rather than live micro-organisms. These non-digestible food ingredients selectively stimulate the growth and metabolic activity of beneficial bacteria in the colon. Probiotics, conversely, are the live microbial strains that provide health benefits to the human host.

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159. (B) DVS reduces phage infection risk by eliminating bulk culture preparation steps
Direct vat set cultures are concentrated cultures designed for direct inoculation into the cheese vat. By bypassing the traditional bulk starter preparation step, they eliminate the need for daily propagation and open transfers in the dairy plant. This process significantly reduces the risk of environmental contamination and subsequent bacteriophage infection.

160. (D) It undergoes surface washings with Brevibacterium linens, producing a red-orange rind
Smear-ripened cheeses are characterized by repeated washing of the cheese surface with a saline solution containing Brevibacterium linens.

to contract, expelling moisture and determining the final moisture levels.

198. (C) A bitter, metallic off-flavor and an overly rigid curd that shatters
Adding a small amount of calcium chloride to cheese milk restores coagulation properties by providing soluble calcium. However, excessive addition of this mineral leads to serious quality defects. The finished curd becomes overly rigid and prone to physical shattering during cutting. Furthermore, excess calcium chloride imparts an undesirable bitter, metallic off-flavor to the cheese.

199. (D) Gouda's mesophilic starter cultures are inactivated or killed above 40°C
In Gouda cheese manufacture, cooking the curd involves adding hot water to wash and heat the mixture to thirty-six to thirty-eight degrees Celsius. The temperature must not exceed forty degrees Celsius because Gouda relies on mesophilic starter cultures. Raising the temperature higher would permanently inactivate or kill these bacteria, preventing crucial acid development.

200. (A) Un-degraded casein from raw cheese that provides the structural emulsion framework
In processed cheese formulation, the term intact casein refers to the portion of casein proteins that remains unhydrolyzed. This intact protein fraction is essential for providing the necessary physical structure and emulsifying capacity. It acts as a stable structural network that entraps fat and water, preventing phase separation during melting and cooling.

201. (B) Triglycerides
During the ripening of Blue cheese, Penicillium roqueforti produces powerful lipolytic enzymes that target milk fat. These lipases hydrolyze triglycerides into free fatty acids, which then undergo beta-oxidation to form methyl ketones. These volatile compounds, such as heptanone and nonanone, are directly responsible for the characteristic pungent aroma and flavor of blue cheese.

202. (B) Basket centrifuges or quark separators
The production of chakka, the intermediate curd used to make shrikhand, requires the removal of excess whey. Traditionally, this is achieved by hanging dahi in muslin cloth, which is slow and labor-intensive. To expedite this process industrially, manufacturers utilize mechanical basket centrifuges or specialized quark separators to continuously separate whey.

203. (A) Using phage-derived enzymes to selectively lyse and kill pathogens in dairy products
The phage-endolysin strategy is a modern biocontrol method used in dairy biotechnology to enhance food safety. Endolysins are highly specific enzymes produced by bacteriophages to cleave the peptidoglycan cell wall of host bacteria from within. Isolating these enzymes allows processors to selectively target and destroy Gram-positive pathogens, such as Listeria monocytogenes, without affecting starter cultures.

204. (C) It uses DNA from food-grade organisms without antibiotic resistance selection markers
For genetic engineering in dairy starter cultures, cloning vectors must be designated as strictly food-grade to ensure public safety. A vector meets this standard if it is constructed using DNA exclusively from food-grade micro-organisms. Crucially, it must not contain clinical antibiotic resistance genes, utilizing food-grade metabolic markers for selection instead.

205. (D) An undefined complex mixture of different lactic acid bacteria possessing high phage resistance
In the cheese industry, a mixed-strain starter culture is an undefined, complex mixture of different lactic acid bacteria strains. Traditionally maintained by back-slopping or propagation, these cultures naturally contain a diverse array of strains. This high biological diversity provides robust protection against bacteriophage infections, as some strains remain resistant if others are attacked.

206. (C) Recombinant bovine chymosin ensures consistent coagulation and minimizes non-specific proteolysis
Recombinant bovine chymosin is a highly purified, single-enzyme coagulant produced through fermentation. Unlike traditional animal rennet, which contains varying amounts of chymosin and pepsin, recombinant chymosin is homogeneous. This high purity ensures consistent milk coagulation times and minimizes non-specific proteolysis, reducing the risk of bitter peptide formation during cheese ripening.

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170. (B) Pregastric esterase
Pregastric esterase is a lipolytic enzyme commonly added in the manufacture of traditional Italian cheeses like Provolone and Romano. This enzyme selectively hydrolyzes milk fat, releasing short-chain free fatty acids such as butyric, caproic, and caprylic acids. These volatile fatty acids are responsible for the distinct pungent flavor and piquancy of these cheeses.

171. (A) Complete denaturation by intense boiling
Enzyme immobilization is a biotechnological method used to restrict enzyme movement, allowing continuous use and recovery. Common physical and chemical techniques include covalent binding to solid supports, entrapment within polymer gels, and cross-linking with glutaraldehyde. Denaturation via boiling destroys the active site structure and enzymatic activity, making it unsuitable for immobilization.

172. (C) The enzyme is denatured during pasteurization, preventing recovery and raising costs
Batch hydrolysis of lactose performed in tanks before thermal processing has significant economic drawbacks. During subsequent pasteurization, the high temperatures permanently denature the active lactase enzyme. This denaturation prevents any potential recovery and subsequent reuse of the enzyme, thereby increasing overall operational costs compared to modern aseptic inline dosing systems.

173. (D) They are small, positively charged, and amphipathic, allowing membrane disruption
Antimicrobial peptides derived from hydrolyzed milk proteins typically exhibit unique structural features. They are generally small peptides possessing a net positive charge and an amphipathic structure, which combines hydrophobic and hydrophilic regions. This specific structure allows them to interact with and disrupt the negatively charged cytoplasmic membranes of target bacteria.

174. (C) It catalyzes both hydrolytic reactions and transgalactosylation reactions
Lactase is a highly versatile enzyme that performs two primary biochemical functions during the processing of milk sugars. In addition to catalyzing the hydrolytic cleavage of lactose into glucose and galactose, it drives transgalactosylation. This secondary pathway synthesizes prebiotic galactooligosaccharides, which are highly beneficial for promoting the growth of gut probiotics.

175. (A) P-4, Q-2, R-1, S-3
Different cheese characteristics result from distinct biochemical mechanisms. Added lipases hydrolyze triglycerides to produce a pungent flavor in Provolone. Accumulation of hydrophobic peptides causes bitterness in Cheddar. Propionic acid fermentation forms the eyes in Swiss cheese, while a migrating pH gradient and proteolysis by surface molds soften the interior of Camembert.

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176. (D) Packed bed reactor
Packed bed reactors are the industry standard for continuous enzymatic hydrolysis of lactose in cheese whey. In this setup, the lactase enzyme is immobilized on a solid support matrix packed inside a column. As the fluid whey passes through the bed, continuous biocatalytic conversion occurs, maximizing processing efficiency and preventing enzyme loss.

177. (A) They inhibit Angiotensin-Converting Enzyme, preventing vasoconstrictor synthesis and brain-derived peptide breakdown.
ACE-inhibitory peptides act as natural antihypertensive agents by blocking the activity of Angiotensin-Converting Enzyme. This enzyme inhibition directly prevents the synthesis of angiotensin two, a highly potent vasoconstrictor. Additionally, blocking the enzyme slows down the degradation of bradykinin, a natural vasodilator, thereby effectively lowering blood pressure within the human cardiovascular system.

178. (C) Natamycin inhibits molds and yeasts without affecting bacterial starters or ripening bacteria
Natamycin is highly preferred for cheese rind treatment because of its highly specific antimicrobial target spectrum. Unlike synthetic chemical preservatives like sorbates, natamycin selectively targets yeasts and molds by binding to membrane ergosterol. It has zero antibacterial activity, meaning it will not inhibit starter cultures or beneficial ripening bacteria on the surface.

179. (A) A bacterial adaptive immune system providing sequence-specific protection against invading bacteriophages
In dairy starter cultures, the CRISPR-Cas system functions as a highly specific, adaptive

This bacterial culture metabolizes amino acids and lipids, producing a sticky red-orange rind and strong, pungent sulfur compounds. This surface activity directly influences the flavor development and softening of the cheese interior.

161. (A) The protruding hydrophilic, negatively charged region of kappa-casein
The steric and electrostatic stability of casein micelles is maintained by the structural arrangement of kappa-casein. This protein is located on the micelle surface, with its hydrophilic and negatively charged C-terminal peptide chain protruding into the aqueous phase. This projecting layer creates steric repulsion, preventing the micelles from aggregating under normal conditions.

162. (C) It slows further acid production, controls moisture, and dictates final pH
Adding sodium chloride during cheese manufacture plays multiple critical roles. Salting draws moisture out of the curd via osmotic pressure, thereby controlling the final moisture content. Furthermore, the elevated salt concentration slows down the metabolic activity of starter bacteria, limiting lactic acid production and successfully determining the final pH of the cheese.

163. (A) Strict hygiene during curd washing and cold chain maintenance below 4°C
Cottage cheese is highly perishable due to its high moisture content and relatively high pH, which favor microbial growth. To maximize shelf life, manufacturers must maintain strict hygiene during curd washing to prevent contamination. Additionally, continuous cold chain management below four degrees Celsius is essential to inhibit the growth of spoilage organisms.

164. (D) To direct and initiate the transcription of the target gene
In recombinant DNA technology, the promoter is a crucial sequence of DNA located upstream of the target gene on a plasmid vector. Its primary biophysical function is to bind RNA polymerase and initiate transcription. This directed binding ensures the efficient and controlled expression of the desired protein within the engineered starter culture.

165. (A) Both (A) and (R) are true and (R) is the correct explanation of (A).
The use of raw milk in short-ripened cheeses is heavily restricted by food safety regulations. Cheeses ripened for less than sixty days retain higher moisture levels and have lower acidity. These physical conditions do not provide a sufficiently hostile environment to ensure the die-off of pathogens, such as Listeria monocytogenes and Salmonella.

166. (C) Remove a calculated amount of fat or add skim milk
Standardizing cheese milk requires adjusting the casein-to-fat ratio to reach the target of zero point seven. Since the natural milk ratio of zero point six-five indicates an excess of fat relative to casein, the operator must correct this imbalance. This is achieved by either removing fat via centrifugation or adding pasteurized skim milk.

167. (D) Measuring the nitrogen soluble in pH 4.6 acetate buffer
Primary proteolysis in cheese ripening involves the initial cleavage of caseins by residual coagulant and plasmin. To monitor this process, the dairy industry measures the nitrogen soluble in a pH four point six acetate buffer. This fraction contains small casein fragments and peptides, serving as an accurate indicator of early protein degradation.

168. (A) Trichloroacetic acid or phosphotungstic acid
Secondary proteolysis involves the breakdown of larger peptides into small peptides and free amino acids by starter enzymes. To measure this, precipitating agents like trichloroacetic acid or phosphotungstic acid are used to separate remaining proteins. The soluble nitrogen fraction in these filtrates accurately reflects the accumulation of highly degraded protein fragments.

169. (B) Gas production by heterofermentative non-starter lactic acid bacteria
The slit defect in Cheddar cheese is characterized by the formation of small, undesirable gas openings. This issue is primarily caused by non-starter heterofermentative lactic acid bacteria that proliferate during ripening. These bacteria ferment residual sugars and organic acids, producing carbon dioxide gas which physically splits the compacted cheese curd structure.

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growth, dairy processors supplement milk with growth-promoting substances. These additives, including yeast extract, protein hydrolysates, peptides, and prebiotics, provide readily available nutrients and growth factors.

189. (D) A longer fermentation, increased exopolysaccharide production, and a viscous gel
In yoghurt manufacture, using a lower incubation temperature slows down the metabolic rate of starter bacteria, extending fermentation time. This mild environmental stress stimulates certain strains of Streptococcus thermophilus and Lactobacillus bulgaricus to produce higher amounts of exopolysaccharides. These natural polymers enhance the water-binding capacity, yielding a highly viscous, smooth gel.

190. (C) Mesophilic cultures have an optimal growth temperature around 25-30°C, while thermophilic cultures thrive at 37-45°C.
The primary technological distinction between mesophilic and thermophilic starter cultures lies in their optimal growth temperatures. Mesophilic cultures, consisting of organisms like Lactococcus lactis, thrive best at moderate temperatures between twenty-five and thirty degrees Celsius. Conversely, thermophilic cultures, such as Streptococcus thermophilus, require higher incubation temperatures ranging from thirty-seven to forty-five degrees Celsius.

191. (B) The Hutin-Stenne process using cold-renneting and rapid heating in pipes
The Hutin-Stenne process revolutionized Cottage cheese manufacture by enabling continuous, automated production. It operates on the principle of cold-renneting, where milk-clotting enzymes are allowed to act on casein at low temperatures without forming a gel. When the milk is rapidly heated as it flows through pipes, coagulation occurs almost instantly, preventing manual handling.

192. (D) Pink defect in cheeses linked to galactose and starter metabolism
The pink discoloration defect in certain cheeses is a non-enzymatic browning reaction related to starter culture metabolism. When starter cultures fail to ferment galactose, this residual sugar accumulates in the cheese matrix. During storage, galactose undergoes Maillard-type reactions with free amino acids, producing a pinkish-brown color that disfigures the cheese body.

193. (A) Beta-galactosidase
The commercial enzyme complex widely known as lactase is scientifically designated as beta-galactosidase. This hydrolase enzyme is responsible for catalyzing the cleavage of the beta-one-four glycosidic bond in lactose, converting this disaccharide into glucose and galactose. It is extensively utilized to manufacture high-quality, lactose-reduced dairy products globally.

194. (C) Operating at low temperatures (4-10°C) with regular, mild sanitation
Immobilized enzyme reactors used for lactose hydrolysis are highly susceptible to microbial contamination due to the rich nutrient stream. To mitigate this risk without denaturing the sensitive enzyme, processors operate the bioreactor at low temperatures between four and ten degrees Celsius. This cold operation is combined with regular, non-denaturing sanitation procedures.

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195. (A) III, I, IV, V, II
The isolation and application of a novel bioactive peptide follows a rigorous scientific pathway. First, researchers identify the target protein sequence. Next, enzymatic hydrolysis cleaves the protein, followed by ultrafiltration and fractionation to concentrate the target peptides. The fraction undergoes in-vitro testing to confirm biological activity before advancing to in-vivo clinical trials.

196. (D) Colonization resistance
The live lactic acid bacteria in fermented milks like dahi and misti dohi provide health benefits through a mechanism called colonization resistance. Once ingested, these beneficial bacteria attach to the intestinal mucosal lining, creating a physical barrier. This colonization competitively excludes and prevents pathogenic micro-organisms from adhering to and colonizing the gut.

197. (B) The cooking temperature and the duration the curd is held
In Cheddar cheese making, controlling the final moisture content of the curd occurs primarily during the cooking stage. Raising the cooking temperature and increasing the duration the curd is held in hot whey accelerates syneresis. This thermal treatment forces the protein matrix

216. (A) To apply dry salt to milled curd pieces on a conveyor prior to pressing
In mechanized Cheddar cheese manufacture, the salting belt is a critical automated processing unit. It is designed to continuously convey milled curd pieces while applying a precise, calculated dosage of dry salt. This mechanical system ensures uniform salt distribution throughout the curd mass before the blocks are transferred to hoops for final pressing.

217. (B) Moisture content, temperature, block geometry, and brine concentration
Salt diffusion into a large cheese block during brining is a mass transfer process driven by physical variables. The rate and extent of this diffusion are strictly governed by the moisture content of the cheese, brine temperature, and salt concentration. Additionally, the geometric dimensions and surface-to-volume ratio of the cheese block dictate diffusion kinetics.

218. (B) Calcium leaches from cheese, making the surface soft, slimy, and dissolvable
Storing Mozzarella cheese in a brine or storage solution that lacks sufficient soluble calcium creates an osmotic imbalance. This mineral gradient causes calcium ions to leach out of the cheese matrix and into the water. This loss of calcium destabilizes the surface casein network, making the cheese outer layer soft, slimy, and dissolvable.

219. (A) Alpha-s1-I-casein
During the initial stages of Cheddar cheese ripening, residual chymosin cleaves intact alpha-sone casein at a specific peptide bond. This primary proteolytic action yields a major peptide fragment designated as alpha-sone-I-casein. Because this cleavage occurs early, measuring the accumulation of this specific peptide serves as a reliable analytical indicator of primary proteolysis.

220. (C) Too acidic and crumbly due to excessive acid production
Washing the curd during Gouda cheese manufacture is a critical step designed to remove whey and lactose. If this washing step is omitted, a high concentration of residual lactose remains in the curd. Starter bacteria will ferment this excess sugar into lactic acid, dropping the pH too low and producing an overly acidic, crumbly cheese.

221. (D) Lactose hydrolysis using beta-galactosidase to produce sweet syrups
Globally, millions of tons of cheese whey permeate are generated as a byproduct of ultrafiltration. To add commercial value to this waste stream, manufacturers utilize beta-galactosidase to hydrolyze lactose into glucose and galactose. This enzymatic conversion yields a highly soluble, sweet syrup that can be used as a sweetener in various food formulations.

222. (C) Simultaneously with standard starter, or before packaging to maximize viability
In probiotic stirred yoghurt production, managing the viability of the probiotic strains is critical. Strains like Bifidobacteria are typically inoculated simultaneously with the standard yoghurt starter culture, or added immediately before the packaging stage. This timing minimizes exposure to the competitive environment and acid stress, ensuring high probiotic cell survival in the final product.

223. (B) The kappa-casein layer maintains steric repulsion; cleavage is required to destabilize it
Normal fluid milk does not coagulate at its natural pH even when heated because of the structural properties of casein micelles. The outer hydrophilic layer of kappa-casein creates continuous steric and electrostatic repulsion that prevents micelle aggregation. Coagulation strictly requires the enzymatic cleavage of this protective layer to destabilize the micelles and permit aggregation.

224. (D) It must target pathogens without inhibiting starters, remaining pH stable
For a bacteriocin to serve as an effective bio-preservative in fermented dairy products, it must meet specific functional criteria. It must selectively target and inhibit pathogenic and spoilage organisms without affecting the active starter cultures. Additionally, the bacteriocin must remain stable and active under the acidic pH and temperature conditions of the food matrix.

225. (A) Stressing cells prevents growth and acid production, but leaves ripening enzymes active
Attenuated starter cultures are used to accelerate cheese ripening without causing over-acidification. These cells are subjected to controlled physical stress, such as mild heat or freezing, before addition. This treatment

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207. (B) Bacterial inhibition leading to a weak body, excessive wheying-off, and acid flavor
Incubating yoghurt at fifty degrees Celsius is highly detrimental because this extreme temperature exceeds the thermal tolerance of standard thermophilic starters. This heat stress severely inhibits the metabolic activity and growth of the bacteria. The resulting incomplete fermentation yields a weak protein gel, leading to excessive wheying-off and an unappealing flavor.

208. (D) An excessively sour taste, thin consistency, and rapid spoilage
Whey retention in chakka is a critical processing defect that directly affects the quality of shrikhand. Because whey contains residual lactose, retaining too much liquid allows starter cultures to continue fermenting. This continuous acid production results in an excessively sour taste, thin consistency, and higher water activity, causing rapid microbial spoilage during storage.

209. (A) Heat-induced coagulation of caseins at low pH, requiring stabilizers like pectin
Post-fermentation pasteurization of lassi poses a significant technological challenge. At the low pH of fermented milk, casein proteins are highly unstable and susceptible to heat denaturation. Applying thermal treatments causes these proteins to aggregate and curdle. To prevent this, manufacturers must add hydrocolloids like pectin to stabilize the protein network before heating.

210. (A) Both (A) and (R) are true and (R) is the correct explanation of (A).
Microfiltration is an effective physical separation technology used to remove bacterial cells and spores from cheese milk. Because bacteria and spores are larger than casein micelles, whey proteins, and dissolved minerals, they are retained by the membrane. Meanwhile, the essential milk components pass through as permeate, preserving the natural functional properties of the milk.

211. (A) Immunomodulatory peptides
Immunomodulatory peptides are a class of bioactive molecules released during the enzymatic digestion of milk proteins like casein and whey. These small peptide fragments actively stimulate the human immune system. Specifically, they have been shown to enhance the phagocytic activity of macrophages and promote lymphocyte proliferation, helping bolster defense mechanisms.

212. (D) Bind and solubilize minerals like calcium and iron, enhancing human absorption
Casein phosphopeptides are functional ingredients formed through the selective enzymatic hydrolysis of casein. These peptides contain clusters of phosphorylated seryl residues that can bind divalent minerals like calcium, magnesium, and iron. By forming soluble organophosphate complexes, they prevent mineral precipitation in the intestine, thereby significantly enhancing mineral absorption in the human body.

213. (B) Opioid-like activity, interacting with receptors in the nervous system
Beta-casomorphins are biologically active peptide fragments derived from the enzymatic digestion of beta-casein, particularly the A1 variant. These peptides are characterized by their specific opioid-like activity. Upon absorption, they interact with opioid receptors in the central nervous and gastrointestinal systems, potentially influencing gut motility and exhibiting mild analgesic or sedative biological effects.

214. (C) Its effectiveness strictly increases as the pH of the food becomes highly alkaline (above pH 8.0).
Nisin is widely used as a bio-preservative designated as E234, particularly to prevent Clostridium spore outgrowth in processed cheese. However, its stability and solubility depend heavily on acidity. Nisin is highly soluble and stable at acidic pH levels, whereas its effectiveness and solubility decrease rapidly as the pH becomes alkaline, especially above pH eight.

215. (D) Most enzyme is lost in whey, creating economic waste and ruining it for other uses
Adding free, unencapsulated proxies directly to cheese milk is an inefficient strategy for accelerating ripening. During coagulation and syneresis, the vast majority of these soluble enzymes partition into the liquid whey stream rather than the curd. This loss creates significant economic waste and contaminates the whey, making it unusable for further processing.

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immune mechanism against viral threats. It works by acquiring short spacer sequences from invading bacteriophage genomes. Upon subsequent infections, these stored sequences guide Cas nucleases to recognize and cleave the matching phage DNA, conferring robust viral resistance to the host.

180. (D) The creaming process, mixing a pasteurized cream dressing with washed, drained curd
Cottage cheese is initially manufactured as dry, unripened curd particles that are low in fat and relatively bland. The defining technological step to adjust the fat content is the creaming process. In this step, a pasteurized, salted cream dressing is mixed with the washed and drained curd, providing flavor, moisture, and smoothness.

181. (B) A culture system where combined growth and acid production exceed the sum of individual rates
A symbiotic starter culture consists of two or more strains that actively support each other through metabolic interactions. In yoghurt, Streptococcus thermophilus and Lactobacillus bulgaricus stimulate each other's growth and metabolic activity. This mutual cooperation results in combined acid production and cell growth that significantly exceed the sum of their individual rates.

182. (C) Excessive fermentation and high temperatures during the whey draining process
A sour, acidic taste and grainy texture in shrikhand are common defects caused by uncontrolled acidity during processing. Excessive fermentation or high temperatures during the crucial whey draining step allow the starter bacteria to continue producing lactic acid. This over-acidification drops the pH too low, destabilizing caseins and causing them to aggregate into grains.

183. (D) It removes 95-98% of anaerobic spores due to their higher density, preventing late blowing
Bactofugation is widely utilized in the cheese industry to physically remove bacterial spores from milk. Because anaerobic spores of Clostridium tyrobutyricum have a higher density than milk plasma, high-force centrifugation can successfully separate them. This continuous process removes ninety-five to ninety-eight percent of spores, effectively preventing late blowing gas defects.

184. (A) Hard, dry, and potentially lacking in typical cheese flavor and smoothness
An excessively high casein-to-fat ratio in cheese milk means there is insufficient fat relative to the protein network. During cheese making, this leads to a highly dense and compacted casein matrix. The resulting cheese will be physically hard, dry, rubbery, and lack the characteristic smooth mouthfeel and flavor development provided by fat.

185. (B) Cleavage of kappa-casein → Release of glycomacropeptide → Decrease in steric repulsion → Micelle destabilization
The primary enzymatic phase of rennet coagulation follows a precise biochemical sequence. First, chymosin cleaves the specific peptide bond of surface kappa-casein, releasing the hydrophilic glycomacropeptide into the whey. This cleavage causes a significant decrease in steric and electrostatic repulsion on the micelle surface, leading directly to micelle destabilization and subsequent aggregation.

NODIA

186. (B) Late gas production by Clostridium
Lysozyme is an enzyme used in the manufacture of certain semi-hard cheeses to target bacterial contamination. It specifically hydrolyzes the peptidoglycan cell walls of Gram-positive organisms, primarily Clostridium tyrobutyricum. This enzymatic action destroys the vegetative cells of Clostridium, effectively preventing late gas production and late blowing defects during extended ripening.

187. (A) To ensure uniform heat transfer, break down the cheese mass, and blend components to form a stable emulsion
Agitation is a critical mechanical step during the heating of the cheese blend in a processed cheese cooker. The continuous shearing action ensures rapid, uniform heat transfer and physical breakdown of the natural cheese blocks. Under heat, this mechanical force blends the proteins, fats, water, and emulsifying salts to establish a stable, homogeneous emulsion.

188. (C) Supplementing milk with growth-promoting substances like yeast extract, peptides, or prebiotics
Probiotic bacteria like Lactobacillus acidophilus and Bifidobacterium bifidum grow slowly in cow's milk because they lack extensive proteolytic activity. To improve their viability and accelerate

prevents cell division, metabolic growth, and active lactic acid production, while keeping the intracellular proteolytic enzymes fully active to hydrolyze proteins during ripening.

226. (C) Homofermentatives produce only lactic acid via glycolysis, while heterofermentatives produce acid, ethanol, and CO_2
Homofermentative and heterofermentative lactic acid bacteria utilize different biochemical pathways to metabolize hexoses. Homofermentative bacteria use glycolysis to ferment lactose, yielding lactic acid as the sole end product. Conversely, heterofermentative bacteria utilize the phosphoketolase pathway, producing lactic acid along with significant amounts of ethanol, carbon dioxide, and other volatile flavor compounds.

227. (A) Compress the curd into a mass, expel residual whey, and shape the cheese
Mechanical pressing of cheese curd in hoops is a crucial physical step in cheese making. Its primary objectives are to physically compress the individual curd pieces into a cohesive solid mass and expel remaining pockets of free whey. This process also shapes the cheese into the standardized dimensions required for subsequent ripening and packaging.

228. (D) A soft cheese inoculated with Penicillium camemberti, forming white surface mycelium
Surface mold-ripened cheeses, such as Camembert or Brie, are soft-bodied cheeses inoculated with Penicillium camemberti spores. During ripening under controlled humidity, the mold germinates and grows, forming a dense white felt-like mycelium over the cheese surface. The metabolic enzymes secreted by this surface flora migrate inward, softening the interior and developing characteristic flavors.

229. (B) Lactose draws water into the gut, where bacteria ferment it into gas and acids
In lactose-intolerant individuals, a lack of the lactase enzyme prevents the digestion of lactose in the small intestine. The unhydrolyzed lactose passes into the large intestine, creating an osmotic gradient that draws water into the bowel. Colonic microflora then ferment the sugar, producing gases and organic acids, which causes acute gastrointestinal distress.

230. (A) II, III, I, IV
The commercial production of Mozzarella cheese follows a precise physical and chemical sequence. The process begins with the coagulation of standardized milk, followed by acidification of the curd to pH five point two to five point four. The curd then undergoes plasticization via stretching in hot water, before being molded and rapidly cooled.

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2015

75. Arrange the following steps in the correct sequence for manufacturing Whey Protein Isolate (WPI) from raw milk:

I. Ultrafiltration and Diafiltration
II. Cheese making / Whey separation
III. Spray drying
IV. Microfiltration for defatting whey

Which of the following represents the correct sequence?

(A) II, IV, I, III
(B) II, I, IV, III
(C) IV, II, I, III
(D) I, II, IV, III

2023

76. What characterizes Milk Protein Concentrate (MPC) compared to Whey Protein Concentrate (WPC)?

(A) MPC contains only whey proteins, whereas WPC contains both casein and whey proteins
(B) MPC is manufactured exclusively and solely through the application of reverse osmosis
(C) MPC contains casein and whey in the same ratio as skim milk.
(D) MPC lacks any micellar structure due to the effects of extensive thermal processing

2022

77. Which process is essential for generating Milk Protein Isolate (MPI) from skim milk?

(A) Continuous thermal evaporative concentration
(B) High-pressure industrial homogenization
(C) Enzymatic chymosin coagulation
(D) Ultrafiltration and diafiltration

2023

78. The fractionation of native micellar casein from whey proteins directly from skim milk is achieved using which membrane technology?

(A) Nanofiltration operating at elevated pressures
(B) Ultrafiltration utilizing a tight 10 kDa MWCO
(C) Microfiltration (0.1-0.2 micrometer)
(D) Reverse Osmosis for complete solute retention

2012

79. When using microfiltration to fractionate milk proteins, what is the primary component of the permeate?

(A) Insoluble micellar casein
(B) Native whey proteins
(C) Large milk fat globules
(D) Residual somatic cells

2012

80. Identify the INCORRECT statement regarding Milk Protein Concentrates (MPC).

(A) MPC production utilizes ultrafiltration to remove lactose and soluble minerals.
(B) MPC retains the native structural integrity of micellar casein.
(C) The solubility of high-protein MPCs can decrease during prolonged storage.
(D) MPC-85 contains significantly more lactose than MPC-50.

2014

81. Which functional property makes Whey Protein Concentrate highly suitable for use in processed meats and bakery products?

(A) High water-binding capacity
(B) Extreme bitterness
(C) Inability to form structural gels under heating
(D) Total insolubility in aqueous solutions at pH 7

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2003

82. The gelation characteristic of Whey Protein Isolate (WPI) is primarily triggered by which factor during food processing?

(A) Continuous exposure to high-intensity ultraviolet light
(B) Rapid mechanical agitation under high vacuum conditions
(C) Thermal denaturation of proteins
(D) Deep freezing of the solution at -20°C

2008

83. Which membrane-derived protein ingredient is recognized for having superior foaming characteristics, making it ideal for aerated desserts?

(A) Whey Protein Isolate
(B) Native micellar casein
(C) Milk permeate powder
(D) High-lactose WPC

2001

84. The emulsifying capacity of Milk Protein Concentrate (MPC) relies heavily on the presence of which surface-active component?

(A) Lactose
(B) Calcium phosphate
(C) Riboflavin
(D) Casein proteins

(D) MF, NF, UF, RO

2004

9. Identify the INCORRECT statement regarding Molecular Weight Cut-Off (MWCO).
(A) It is expressed in Daltons and defines the overall nominal separation capability of a porous membrane.
(B) It defines a threshold where 100 percent of all larger molecules are completely rejected.
(C) It typically corresponds to the molecular weight of a reference solute that is 90 percent rejected by the membrane.
(D) It is primarily used as a metric to characterize ultrafiltration and nanofiltration membranes in industry.

2022

10. Which membrane process typically utilizes pore sizes in the range of 0.1 to 10 micrometers?
(A) Reverse Osmosis
(B) Microfiltration
(C) Nanofiltration
(D) Ultrafiltration

2010

11. What is the primary characteristic of cellulose acetate when used as a polymeric membrane material?
(A) High hydrophilicity and low fouling tendency
(B) High tolerance to extremely low or high pH levels
(C) Exceptional resistance to highly elevated temperatures
(D) Stability against strong oxidizing agents

2017

12. Polysulfone and polyethersulfone membranes are widely used in dairy processing primarily due to which advantage?
(A) Complete resistance to aggressive chlorine chemical attack
(B) Extremely high surface hydrophilicity compared to standard cellulose acetate
(C) Broad pH and temperature tolerance during cleaning
(D) Natural structural resistance to severe protein adsorption on the surface

2001

13. Polyamide membranes are most commonly associated with which type of pressure-driven process due to their specific chemical structure?
(A) Microfiltration
(B) Gel filtration
(C) Electrodialysis
(D) Reverse Osmosis

2001

14. Which physical property of a membrane refers to its ability to attract water, thereby reducing protein-based fouling?
(A) Hydrophobicity
(B) Tortuosity
(C) Hydrophilicity
(D) Porosity

2013

15. Identify the correct option after analyzing the given assertion (A) and reason (R).
Assertion (A): Ceramic membranes are often preferred over polymeric membranes for processing streams with high fouling potential.
Reason (R): Ceramic membranes can withstand aggressive cleaning regimes, including high temperatures and wide pH ranges.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2021

16. Among inorganic membrane materials, which compound is most frequently used to manufacture the active layer of ceramic membranes in dairy applications?
(A) Silicon carbide
(B) Glass
(C) Stainless steel
(D) Zirconia

2004

17. What is a distinct disadvantage of utilizing titania and alumina ceramic membranes compared to polymeric types?
(A) High cost and structural brittleness
(B) Lower chemical resistance to organic cleaning solvents
(C) Inability to withstand industrial steam sterilization cycles
(D) Significantly narrower operating pH range under pressure

2017

18. Which structural property provides ceramic membranes with a longer operational lifespan than polymeric membranes?
(A) High physical compressibility under dynamic transmembrane pressure
(B) Natural structural flexibility of the inorganic

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structural matrix
(C) Superior strength and chemical inertness
(D) Extreme susceptibility to rapid enzymatic or chemical degradation

2008
19. Identify the correct pair matching the module configuration with its primary characteristic.
(A) Plate-and-frame module - Easy membrane replacement and visual inspection
(B) Spiral-wound module - Highest tolerance for suspended solids
(C) Hollow fiber module - Requires the highest floor space per membrane area
(D) Tubular module - Highest packing density available

2003
20. Which membrane module configuration typically offers the highest packing density (surface area per unit volume)?
(A) Tubular
(B) Plate-and-frame
(C) Spiral-wound
(D) Hollow fiber

2013
21. What is the main operational advantage of a tubular membrane module in dairy processing?
(A) Extremely low energy consumption for high-velocity cross-flow pumping
(B) Ability to process highly viscous particulate fluids
(C) Extremely high packing density minimizing the physical plant footprint
(D) Significantly lower capital investment costs among all module types

2006
22. In a spiral-wound membrane module, what is the function of the feed spacer?
(A) To provide robust structural support to the central permeate collection tube
(B) To act as a selective semi-permeable barrier for targeted separations
(C) To promote turbulence and reduce polarization
(D) To securely seal the outer edges of the multi-layered membrane envelope

2007
23. Which plant layout configuration is most suitable for small-scale operations processing a single specific product volume per day?
(A) Continuous single-pass system
(B) Multi-stage continuous system
(C) Feed-and-bleed configuration
(D) Batch processing system

2007
24. How does a feed-and-bleed membrane configuration operate?
(A) A portion of retentate is recirculated while the rest is continuously drawn off.
(B) The entire volume of retentate is completely discarded after a single pass through the module.
(C) Permeate is continuously remixed with the feed tank to systematically dilute the feed concentration.
(D) The system operates at a continuously and systematically decreasing transmembrane pressure level.

2005
25. Match the mathematical parameters of membrane separation in List I with their corresponding definitions in List II:
List I: (Parameter)
P. Volume Concentration Factor (VCF)
Q. Retention Coefficient
R. Diafiltration Ratio
S. Permeate Flux
List II: (Definition)
1. Volume of added water divided by the initial feed volume
2. Initial feed volume divided by the final retentate volume
3. Flow rate of permeate per unit membrane area
4. One minus the ratio of permeate concentration to retentate concentration
(A) P-2, Q-4, R-1, S-3
(B) P-1, Q-3, R-2, S-4
(C) P-2, Q-1, R-4, S-3
(D) P-4, Q-2, R-1, S-3

2022
26. Which scenario best describes a continuous single-pass membrane system?
(A) The feed fluid is continuously recirculated multiple times until the desired high concentration is reached.
(B) The feed fluid passes through the module once and retentate is collected.
(C) Multiple filtration stages are used, but retentate is constantly and systematically returned to the first stage.
(D) Pure deionized water is added continuously to the feed to systematically wash out all small molecules.

NODIA

2021

27. What is the primary purpose of designing a multi-stage membrane plant rather than a single-stage system for large-scale operations?
(A) To maintain uniform flux and optimize stage energy
(B) To significantly increase the total cumulative amount of native protein rejected by the system
(C) To allow the simultaneous use of completely different membrane materials within the same process line
(D) To completely eliminate the operational need for routine chemical cleaning-in-place procedures

2011

28. If 1000 liters of skim milk are ultrafiltered to a retentate volume of 200 liters, what is the Volume Concentration Factor (VCF)?
(A) 2
(B) 4
(C) 5
(D) 8

2017

29. The retention coefficient for a specific solute is calculated as 0.95. What does this signify?
(A) 95 percent of the solute is found in the permeate.
(B) The permeate flux has decreased by 5 percent.
(C) The concentration in the retentate is 95 times higher than the feed.
(D) 95 percent of the solute is retained by the membrane.

2014

30. During mass balance calculations for a simple batch concentration process, which equation accurately relates feed mass (M_f), retentate mass (M_r), and permeate mass (M_p)?
(A) $M_f = M_r - M_p$
(B) $M_r = M_f + M_p$
(C) $M_f = M_r + M_p$
(D) $M_p = M_f \times M_r$

2006

31. Which of the following defines the condition where a solute is freely permeable through the membrane?
(A) Retention coefficient is 1.0
(B) Retention coefficient is 0.0
(C) Retention coefficient is 0.5
(D) Retention coefficient is negative

2022

32. In the modeling of ultrafiltration processes, what describes the accumulation of retained solutes at the membrane surface?
(A) Osmotic pressure differential
(B) Isoelectric precipitation
(C) True fouling
(D) Concentration polarization

2023

33. The film theory model uses which parameter to describe the back-transport of solutes from the membrane surface to the bulk fluid?
(A) Mass transfer coefficient
(B) Kinematic fluid viscosity
(C) Solute reflection coefficient
(D) Hydraulic pore permeability

2025

34. What occurs when the solute concentration at the membrane surface reaches its maximum thermodynamic limit according to the gel layer model?
(A) Permeate flux begins to increase exponentially over time
(B) Transmembrane pressure drops rapidly to a value of zero
(C) Permeate flux becomes independent of pressure.
(D) The membrane pores undergo sudden and severe thermal expansion

2006

35. Arrange the events in the proper sequence during the development of concentration polarization in an ultrafiltration module:
I. Accumulation of solutes at the membrane surface
II. Application of transmembrane pressure
III. Establishment of a steady-state concentration boundary layer
IV. Convective transport of solutes towards the membrane
Which of the following represents the correct sequence?
(A) II, IV, I, III
(B) IV, II, I, III
(C) II, I, IV, III
(D) I, II, IV, III

2019

36. Which factor is most directly responsible for mitigating the thickness of the concentration polarization boundary layer?

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(A) Decreasing feed temperature
(B) Increasing transmembrane pressure
(C) Using a membrane with a lower MWCO
(D) Increasing cross-flow velocity

2021

37. Identify the INCORRECT distinction between concentration polarization and true membrane fouling.
(A) Concentration polarization is completely and fully reversible upon the removal of transmembrane pressure.
(B) Concentration polarization occurs only in dead-end filtration.
(C) True membrane fouling involves irreversible chemical adsorption or precipitation of solutes onto the membrane.
(D) True membrane fouling physically and permanently alters the internal pore structure or surface properties.

2012

38. Which type of fouling is characterized by the physical deposition of particles that can be easily removed by hydraulic backwashing?
(A) Irreversible fouling
(B) Chemical adsorption
(C) Reversible fouling
(D) Biological colonization

2014

39. In dairy processing, which component is notorious for precipitating onto the membrane surface under specific pH and temperature conditions, causing severe inorganic fouling?
(A) Free milk lactose
(B) Soluble riverflavin
(C) Free butyric acid
(D) Calcium phosphate

2002

40. Protein adsorption onto a membrane surface is heavily influenced by which physicochemical parameter?
(A) The protein's isoelectric point
(B) The local ambient atmospheric pressure
(C) The visual color profile of the feed liquid
(D) The bulk concentration of lactose sugar

2007

41. What is the most appropriate primary mitigation strategy for controlling concentration polarization in an industrial cross-flow microfiltration unit?
(A) Decreasing the incoming feed temperature to near freezing points
(B) Optimizing the cross-flow velocity
(C) Continually and systematically increasing transmembrane pressure
(D) Adding synthetic chemical defoamers directly to the feed tank

2021

42. Uniform Transmembrane Pressure (UTMP) principles are applied primarily to resolve which issue in long tubular or ceramic modules?
(A) Low permeate flux at the inlet and extreme fouling at the module outlet
(B) High fouling at the inlet due to excessive pressure
(C) The inability to clean the module using standard alkaline detergents
(D) The structural physical failure of the membrane support matrix

2017

43. How does back-pulsing differ from traditional backwashing in membrane operation?
(A) Back-pulsing involves brief, frequent reversals of permeate flow.
(B) Back-pulsing uses aggressive chemical agents, whereas backwashing uses only water.
(C) Back-pulsing is performed only when the filtration system is shut down for CIP cycles.
(D) Back-pulsing applies high pressure from the retentate side to clear internal pores.

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2012

44. What is the function of turbulence promoters introduced into membrane modules?
(A) To chemically break down protein foulants
(B) To filter out large particulate matter before it reaches the membrane
(C) To increase the Reynolds number and enhance back-transport of solutes
(D) To decrease the overall operational temperature of the fluid

2011

45. Consider the following statements about membrane fouling mitigation strategies:
I. High cross-flow velocities decrease the thickness of the boundary layer.
II. UTMP systems utilize permeate recirculation to equalize pressure drop.
III. Turbulence promoters significantly reduce the energy required for pumping.
IV. Back-pulsing is effectively applied in spiral-wound polymeric modules to prevent pore blocking.
Which of the above statements are INCORRECT?
(A) I and II

(B) III and IV
(C) I and IV
(D) II and III

2025
46. What is the typical first sequential step in a standard Cleaning-in-Place (CIP) protocol for dairy membrane systems?
(A) Acid circulation specifically to remove inorganic minerals
(B) High-concentration alkaline wash targeted at protein removal
(C) Warm water rinse to purge residual fluid
(D) Enzymatic treatment specifically formulated for lipid breakdown

2005
47. Alkaline cleaning agents in CIP protocols are primarily targeted at removing which type of membrane foulant?
(A) Insoluble calcium phosphate precipitates
(B) Adsorbed proteins and organics
(C) Highly concentrated lactose crystals
(D) Stubborn inorganic mineral scales

2022
48. Acidic cleaning regimes are specifically incorporated into membrane CIP protocols to address which issue?
(A) Complete removal of persistent microbial biofilms
(B) Chemical saponification of residual milk fat
(C) Acidic hydrolysis of stubborn whey protein deposits
(D) Solubilization of mineral scale

2004
49. Enzymatic cleaning is most advantageous for which type of membrane where high pH alkaline cleaners cannot be used?
(A) Cellulose acetate
(B) Inorganic ceramic membranes
(C) Porous stainless steel membranes
(D) Specialized glass membranes

2015
50. Which variable must be strictly controlled during the alkaline cleaning step to prevent structural degradation of delicate polymeric membranes?
(A) Total organic carbon level
(B) Transmembrane pressure drop
(C) Cleaning solution temperature
(D) Environmental humidity

2014
51. Polyamide RO membranes possess a known chemical vulnerability to which common sanitization agent?
(A) Free chlorine
(B) Citric acid
(C) Sodium hydroxide
(D) Hydrogen peroxide

2025
52. Which membrane material demonstrates the highest tolerance to extreme pH levels and high temperatures during sanitization?
(A) Polyethersulfone polymers
(B) Cellulose acetate
(C) Polyamide
(D) Zirconia (Ceramic)

2021
53. Hydrogen peroxide is frequently used for membrane sanitization due to which specific characteristic?
(A) It significantly strengthens the polymer matrix of cellulose acetate
(B) It degrades into water and oxygen, leaving no residue.
(C) It selectively dissolves stubborn mineral scale without affecting proteins
(D) It provides a highly permanent antimicrobial coating on the active surface

2014
54. Why must the pH be carefully monitored when utilizing chlorine-based sanitizers on compatible polymeric membranes?
(A) At high pH values, chlorine rapidly forms highly dangerous and toxic gas clouds.
(B) A strictly neutral pH completely and immediately neutralizes the sanitizing effect.
(C) At low pH, the active species is more aggressive toward polymers.
(D) Chlorine chemical species cannot dissolve in water unless the solution pH is above 10.

NODIA

2003
55. Identify the correct option after analyzing the given assertion (A) and reason (R).
Assertion (A): Microfiltration is commonly used for the cold pasteurization of skim milk.
Reason (R): Microfiltration membranes have pore sizes small enough to reject all dissolved whey proteins while allowing bacteria to pass into the permeate.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the

CHAPTER 08

Membrane Processing for Dairy Applications

2001

1. What is the primary driving force for separation in microfiltration and ultrafiltration processes?
(A) Transmembrane pressure
(B) Concentration gradient
(C) Osmotic pressure
(D) Electrical potential

2006

2. Which mathematical model is traditionally used to predict the osmotic pressure of a solution in membrane separation?
(A) Hagen-Poiseuille equation
(B) Darcy's law
(C) van't Hoff equation
(D) Kozeny-Carman equation

2004

3. In the context of mass transfer mechanics, which parameter dynamically balances the feed pressure, retentate pressure, and permeate pressure?
(A) Transmembrane pressure
(B) Concentration polarization
(C) Volume concentration factor
(D) Permeate flux

2023

4. Which of the following statements regarding semi-permeability in membrane processing is most accurate?
(A) It relies solely on the electrical charge properties of the active membrane surface.
(B) It allows solvent to pass while completely rejecting all solutes regardless of molecular size.
(C) It is governed exclusively by the chemical concentration gradient across the separation barrier.
(D) It describes the selective transport of molecules based on size, shape, and charge.

2016

5. Consider the following statements regarding the principles of membrane separation:
I. Osmotic pressure acts in opposition to the applied hydrostatic pressure in reverse osmosis.
II. The van't Hoff equation assumes ideal solution behavior for calculating osmotic pressure.
III. Concentration gradients are the primary driving force in pressure-driven membrane processes.
Which of the above statements are correct?
(A) I and II
(B) I and III
(C) II and III
(D) I, II and III

2016

6. According to Darcy's law, the permeate flux in a membrane process is directly proportional to which variable?
(A) Membrane thickness
(B) Dynamic viscosity of the permeate
(C) Transmembrane pressure
(D) Retentate concentration

2003

7. How does the Hagen-Poiseuille equation relate to flux prediction in porous membranes?
(A) It predicts the onset of concentration polarization during reverse osmosis filtration.
(B) It calculates the exact molecular weight cut-off value for ultrafiltration membranes.
(C) It determines the rate of structural membrane fouling over extended operational runs.
(D) It models fluid flow through cylindrical pores of uniform radius.

2021

8. Which of the following represents the correct classification of pressure-driven membrane processes in increasing order of operating pressure?
(A) RO, NF, UF, MF
(B) MF, UF, NF, RO
(C) UF, MF, RO, NF

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List I: (Process)
P. Microfiltration
Q. Ultrafiltration
R. Nanofiltration
S. Reverse Osmosis
List II: (Application)
1. Standardization of milk protein
2. Pre-concentration of whey without salt removal
3. Spore removal for ESL milk
4. Partial demineralization of whey
(A) P-3, Q-1, R-4, S-2
(B) P-1, Q-3, R-2, S-4
(C) P-3, Q-4, R-1, S-2
(D) P-4, Q-1, R-3, S-2

2021
66. Diafiltration is an essential membrane processing step when the objective is to produce which of the following?
(A) High-lactose whey powder products
(B) Partially defatted skim milk streams
(C) Whey Protein Isolate (WPI)
(D) Condensed whole milk concentrates

2018
67. During diafiltration, what is physically added to the retentate stream to facilitate the purification process?
(A) Reverse osmosis water
(B) Concentrated hydrochloric acid
(C) Isotonic sodium chloride solution
(D) Denatured whey protein aggregates

2017
68. The mechanism of diafiltration involves reducing the concentration of which components in the final retentate?
(A) Casein micelles and fat globules
(B) Immunoglobulins and lactoferrin
(C) Total solids including all proteins
(D) Lactose and soluble minerals

2023
69. If a diafiltration process adds an amount of water equal to the current volume of the retentate, this represents how many diavolumes?
(A) 0.5
(B) 1
(C) 2
(D) 10

2003
70. Why is diafiltration performed continuously rather than in a batch discontinuous mode in large-scale dairy operations?
(A) Batch diafiltration is completely incapable of washing out any lactose sugars
(B) Continuous mode ensures that the permeate flux always increases exponentially
(C) Continuous mode requires less water for the same purification.
(D) Batch mode immediately denatures proteins due to severe osmotic pressure shock

2025
71. Whey Protein Concentrate 34 (WPC-34) indicates that the powder contains approximately 34 percent of what component on a dry basis?
(A) Lactose
(B) Total solids
(C) Ash
(D) Protein

2010
72. Which membrane process is primarily responsible for the manufacture of WPC from sweet whey?
(A) Ultrafiltration
(B) Microfiltration
(C) Reverse Osmosis
(D) Electrodialysis

NODIA

2019
73. To manufacture Whey Protein Isolate (WPI), which typically contains over 90% protein on a dry basis, which combination of processes is strictly necessary?
(A) Reverse Osmosis followed directly by Nanofiltration steps
(B) Ultrafiltration and diafiltration
(C) Microfiltration processes followed immediately by thermal evaporation
(D) Centrifugation combined with extensive thermal protein precipitation

2013
74. How does the processing parameter of transmembrane pressure affect the grading of whey protein ingredients during ultrafiltration?
(A) Higher pressure guarantees maximum protein purity by forcing more protein through the membrane
(B) Excessive pressure causes fouling, lowering protein purity.
(C) Transmembrane operating pressure has absolutely no direct impact on the final composition of powder
(D) Low operating pressure completely prevents any lactose from passing through the membrane pores

correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2011
56. What is the primary objective of applying microfiltration in the production of Extended Shelf-Life (ESL) milk?
(A) To remove somatic cells and spores
(B) To concentrate lactose to inhibitory levels to prevent microbial growth
(C) To physically homogenize milk fat globules under dynamic high pressure
(D) To completely and selectively remove all immunoglobulins from the feed

2022
57. In the process of defatting whey, microfiltration acts to remove which specific component to improve subsequent processing?
(A) Soluble non-protein nitrogen compounds such as urea
(B) Residual lipid complexes and phospholipids
(C) Dissolved calcium phosphate and other mineral complexes
(D) Native beta-lactoglobulin and alpha-lactalbumin proteins

2007
58. Cold pasteurization via microfiltration offers which distinct advantage over traditional thermal pasteurization?
(A) Complete and absolute elimination of all viable viral particles in milk
(B) Preservation of flavor compounds and native proteins
(C) Zero overall electrical or thermal energy expenditure during processing
(D) Simultaneous thermal concentration of milk fat solids and lactose sugar

2013
59. Which membrane pore size is typically targeted for the effective removal of bacterial spores from skim milk?
(A) 0.01 micrometers
(B) 0.1 micrometers
(C) 1.4 micrometers
(D) 10 micrometers

2012
60. Reverse Osmosis (RO) is applied in dairy processing primarily for which function?
(A) Highly selective fractionation of casein and whey proteins from skim milk
(B) Selective removal of monovalent ions to achieve partial demineralization
(C) Pre-concentration of milk or whey by water removal
(D) Complete sterilization of raw milk without using thermal heat treatments

2005
61. How does Nanofiltration (NF) differ from Reverse Osmosis (RO) regarding its separation characteristics?
(A) NF completely rejects all mineral components, whereas RO allows all minerals to pass through.
(B) NF operates at significantly and consistently higher pressure levels than Reverse Osmosis.
(C) NF membranes inherently have larger nominal pores than standard ultrafiltration membranes.
(D) NF passes monovalent ions while rejecting polyvalent ions and organics.

2013
62. Which membrane technology is specifically utilized for the recovery of cow water (milk condensate) in a dairy plant?
(A) Microfiltration
(B) Ultrafiltration
(C) Reverse Osmosis
(D) Electrodialysis

2006
63. The partial demineralization of whey using nanofiltration is highly beneficial because it allows for the simultaneous concentration of whey and the removal of which component?
(A) High molecular weight proteins
(B) Lactic acid and monovalent salts
(C) Emulsified fat
(D) Dissolved oxygen

2025
64. What constitutes the primary economic advantage of using RO for pre-concentrating whey prior to evaporation?
(A) RO completely prevents any subsequent lactose crystallization from occurring
(B) RO entirely eliminates the operational need for any subsequent drying steps
(C) RO selectively and specifically concentrates high-value whey proteins only
(D) Thermal energy required for subsequent evaporation is reduced.

2014
65. Match the membrane processes in List I with their specific dairy applications in List II:

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2012

85. Consider the following statements about functional properties of membrane-derived proteins:

I. WPI generally exhibits higher solubility than MPC at a neutral pH.

II. Gelation of whey proteins is an irreversible physical transformation.

III. The water-binding capacity of MPC decreases as the protein concentration increases from 50% to 85%.

IV. Fractionated native whey proteins exhibit better functional properties than cheese whey proteins.

V. Foaming requires proteins to rapidly adsorb and unfold at the air-water interface.

Which of the above statements are correct?

(A) I, II, IV, and V
(B) II, III, IV, and V
(C) I, II, III, and V
(D) I, III, IV, and V

2012

86. How does solubility impact the application of high-protein Milk Protein Isolates (MPI) in ready-to-drink nutritional beverages?

(A) Low solubility causes desirable thick viscosity profiles
(B) Incomplete hydration leads to sedimentation.
(C) Solubility issues completely prevent addition of flavorings
(D) High solubility values guarantee absolute microbial stability

2018

87. In the recovery of high-purity lactose, ultrafiltration is utilized to achieve what crucial objective?

(A) To crystalize the lactose directly inside the membrane module
(B) To enzymatically hydrolyze lactose into glucose and galactose
(C) To highly concentrate the lactose stream to 80% total solids
(D) To remove proteins prior to crystallization

2004

88. Permeate processing via nanofiltration serves which dual purpose in carbohydrate recovery?

(A) Desalting and concentration
(B) Protein recovery and complete fat separation
(C) Spore removal and rapid thermal pasteurization
(D) Fermentation and continuous pH adjustment

2011

89. The formulation of low-lactose milk powders often integrates ultrafiltration to physically remove lactose, combined with which enzymatic process?

(A) Addition of active chymosin
(B) Addition of lactase
(C) Addition of active lipase
(D) Addition of active protease

2009

90. Which membrane process is least relevant to the direct recovery of solid crystallized lactose?

(A) Ultrafiltration for protein removal
(B) Microfiltration for spore removal
(C) Nanofiltration for permeate concentration
(D) Reverse Osmosis for volume reduction

2006

91. What is the fundamental difference between standardizing milk protein via ultrafiltration versus traditional methods?

(A) UF standardizes protein without adding non-dairy solids.
(B) UF standardizes by extensively diluting the incoming milk with pure deionized water
(C) UF chemically alters the micellar structure of casein to systematically increase yield
(D) Traditional methods inherently require much higher operating pressures than standard UF

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2005

92. The concept of "liquid pre-cheese" in ultrafiltration refers to which process state?

(A) Skim milk that has been fully curdled and then carefully homogenized
(B) Whey that has been concentrated and systematically returned to the cheese vat
(C) Skim milk concentrated to the cheese solids content
(D) Raw milk treated with active lactase enzyme prior to renneting

2013

93. How does standardizing milk protein content using ultrafiltration impact the Rennet Coagulation Time (RCT)?

(A) It significantly increases RCT due to lower systemic calcium availability in the serum
(B) It completely eliminates the operational need for adding active rennet entirely
(C) It makes the subsequent coagulation time completely and totally unpredictable
(D) It generally decreases RCT due to closer micelle proximity.

casein, whereas co-precipitates consist exclusively of whey protein fractions.
(C) MPI preserves proteins in their native, soluble state, whereas co-precipitates undergo irreversible structural denaturation.
(D) MPI has a significantly lower overall protein concentration on a dry matter basis compared to typical co-precipitates.

2021
129. How does the presence of residual lipids negatively impact the functional properties of Whey Protein Concentrate (WPC)?
(A) It significantly increases the overall foaming capacity of the reconstituted powder.
(B) It renders the final WPC completely soluble even at its native isoelectric point.
(C) It causes the dehydrated powder to exhibit an excessively white physical appearance.
(D) It leads to off-flavors from lipid oxidation and impairs foaming and gelation properties.

2024
130. The water-binding capacity of a membrane-derived protein ingredient dictates its usefulness in which specific food application?
(A) Clarification and stabilization of organic fruit juices.
(B) Formulation of highly acidic, clear sports nutrition drinks.
(C) Viscosity enhancement and moisture retention in meat products.
(D) Complete prevention of enzymatic browning reactions in baked goods.

2006
131. Which equation most accurately reflects the mass balance for a solute during diafiltration, assuming a constant retentate volume?
(A) $C = C_0 + \left(\frac{V_d}{V_r}\right)$
(B) $C = C_0 \exp\left(-\frac{V_d}{V_r}\right)$
(C) $C = C_0 \ln(V_d)$
(D) $C = \frac{C_0}{V_r}$

2019
132. In the design of a feed-and-bleed system, what is the primary purpose of the recirculation loop?
(A) To rapidly cool the extracted permeate stream down to 4°C to prevent any microbial growth.
(B) To continuously clean and sanitize the membrane module without interrupting the production run.
(C) To ensure that the entirety of the lactose content is fully converted into organic lactic acid.
(D) To maintain high cross-flow velocity across the membrane without requiring a massive feed pump.

2006
133. Which variable most strongly influences the choice between a continuous single-pass system and a multi-stage system?
(A) The required volumetric capacity and desired final concentration.
(B) The physical color and light-scattering properties of the raw milk.
(C) The specific heat capacity and thermal conductivity of the final product.
(D) The local commercial availability and cost of chemical sanitizers.

2021
134. Which phenomenon is characterized by a rapid, initial drop in permeate flux within the first few minutes of operating a clean ultrafiltration module?
(A) Accelerated physical and chemical degradation of the active membrane polymer layer.
(B) Complete depletion of all primary dissolved solutes within the main feed tank.
(C) Establishment of the concentration polarization layer and initial protein adsorption.
(D) Sudden mechanical or electrical failure of the main high-pressure feed pump.

2003
135. Match the membrane cleaning agents in List I with their primary chemical functions in List II:
List I: (Cleaning Agent)
P. Sodium hydroxide
Q. Nitric acid
R. Protease
S. Hydrogen peroxide
List II: (Chemical Function)
1. Hydrolysis of peptide bonds under mild conditions
2. Dissolution of calcium phosphate scale
3. Saponification of fats and swelling of proteins
4. Sanitization through strong oxidation
(A) P-3, Q-2, R-1, S-4
(B) P-2, Q-3, R-1, S-4
(C) P-3, Q-1, R-4, S-2

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(D) The flux will remain unchanged.

2009

104. Which term accurately defines the difference between the applied hydrostatic pressure and the osmotic pressure differential across a membrane?
(A) Net driving pressure
(B) Rejection efficiency
(C) Absolute flux drop
(D) Hydrodynamic tortuosity

2017

105. Match the membrane module configurations in List I with their characteristic packing density ranges in List II:
List I: (Module Configuration)
P. Tubular
Q. Plate-and-frame
R. Spiral-wound
S. Hollow fiber
List II: (Packing Density Range)
1. Very High ($> 1000 \frac{m^2}{m^3}$)
2. Low ($< 300 \frac{m^2}{m^3}$)
3. High (300-1000 $\frac{m^2}{m^3}$)
4. Moderate (100-400 $\frac{m^2}{m^3}$)

(A) P-2, Q-4, R-3, S-1
(B) P-1, Q-3, R-2, S-4
(C) P-3, Q-1, R-4, S-2
(D) P-4, Q-2, R-1, S-3

2007

106. In terms of chemical structure, what distinguishes polyethersulfone (PES) from standard polysulfone (PS) membranes?
(A) PES completely lacks aromatic rings in its chemical structure
(B) PES contains more sulfone groups, granting hydrophilicity.
(C) PES is fundamentally derived from regenerated cellulose sources
(D) PES possesses a highly crystalline structure compared to PS

2018

107. Which inference can be made if a membrane demonstrates a rejection coefficient of 0.2 for sodium chloride and 0.98 for lactose?
(A) The membrane is functioning as a nanofiltration module.
(B) The membrane is functioning as a microfiltration module.
(C) The membrane has lost its semi-permeable integrity.
(D) The operating pressure is too low to reject salt.

2019

108. Why is the control of calcium phosphate precipitation critical during the membrane processing of milk?
(A) It causes the processed milk to turn excessively white
(B) It chemically dissolves standard polymeric membrane materials
(C) It forms an irreversible scale, restricting flux.
(D) It ferments lactose into lactic acid prematurely in the tank

2018

109. What is the fundamental cause of a gradual decline in permeate flux over an extended processing run, even when cross-flow velocity is optimized?
(A) Continuous decrease in feed temperature during the process
(B) Spontaneous physical enlargement of the membrane pores
(C) Complete depletion of lactose sugars in the retentate
(D) Accumulation of foulants leading to blocking

2011

110. Which operational modification is most appropriate to prevent severe protein denaturation during the prolonged batch ultrafiltration of whey?
(A) Raising the overall process operating temperature to 90°C
(B) Introducing atmospheric air vigorously into the feed tank
(C) Utilizing cooling mechanisms to maintain low temperatures
(D) Adjusting the systemic pH of the whey to an acidic level of 2.0

2022

111. Identify the CORRECT statement regarding diafiltration ratios.
(A) A higher diafiltration ratio implies a much lower degree of purification
(B) Solute removal follows a logarithmic decay.
(C) The ratio has no mathematical correlation with the final concentration
(D) Adding all diawater at once is more efficient than adding it continuously

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(D) Permeate flow velocity

2019

158. What is the primary reason that cold pasteurization of milk via microfiltration is typically performed on skim milk rather than whole milk?

(A) Microfiltration physically ruptures the fat globule membrane, causing rapid enzymatic rancidity.

(B) Fat globules and bacteria are similar in size, causing concurrent retention and rapid clogging.

(C) Whole milk exhibits excessive viscosity, making it impossible to pump through standard modules.

(D) Effective cold pasteurization requires the lipid phase to be completely frozen prior to filtration.

2007

159. When formulating low-lactose milk powders, what is the sequence of unit operations following milk standardization?

(A) Ultrafiltration → Diafiltration → Enzymatic hydrolysis → Spray drying

(B) Spray drying → Enzymatic hydrolysis → Ultrafiltration

(C) Enzymatic hydrolysis → Reverse Osmosis → Microfiltration

(D) Microfiltration → Spray drying → Ultrafiltration

2021

160. Which operational approach characterizes a batch membrane concentration process?

(A) Fresh feed is continuously supplied while retentate is continuously withdrawn at the final concentration.

(B) The fluid passes through the membrane system once and is then immediately directed to a spray drying tower.

(C) A fixed feed volume is recirculated, removing only permeate until the target concentration is reached.

(D) Permeate is continuously re-injected back into the incoming feed line to maintain a constant system volume.

2021

161. The use of Ultrafiltration to standardize cheese milk yields a retentate that alters the rennet coagulation process. What specific physical change occurs during gel formation?

(A) The enzymatic gel forms much more slowly and exhibits a weaker structure.

(B) The resulting gel becomes rubbery and completely resists standard cutting.

(C) The gel completely fails to expel any whey during the subsequent cooking step.

(D) The gel forms faster and achieves a firmer curd tension in less time.

2013

162. How does the concept of "film theory" mathematically model the flux during the concentration polarization phase?

(A) It mathematically equates the permeate flux to the direct thermodynamic inverse of physical membrane thickness.

(B) It assumes that permeate flux remains strictly proportional to the applied transmembrane pressure up to infinity.

(C) Flux is modeled as the mass transfer coefficient multiplied by the log ratio of wall to bulk concentration.

(D) It calculates the overall permeate flux rate solely based on the dynamic viscosity profile of the permeate stream.

2024

163. The functional property of emulsification in Milk Protein Concentrates makes them extremely valuable in the production of which food product?

(A) Clear sports hydration beverages.

(B) Processed cheese spreads and coffee creamers.

(C) Highly purified crystalline lactose powder.

(D) Hard candies and high-sugar confections.

2012

164. What is the most appropriate strategy for dealing with irreversible organic fouling on a spiral-wound polymeric membrane?

(A) Applying a highly abrasive mechanical scrub brush directly to the delicate polymer surface.

(B) Heating the entire module housing to 150°C to thermally burn off the accumulated organics.

(C) Running the entire system in reverse by heavily pressurizing the clean permeate collection line.

(D) Initiating an aggressive chemical CIP cycle precisely tailored to the specific organic foulant.

2002

165. Given below are two statements, one labeled as Assertion (A) and the other labeled as Reason (R):

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2012

120. Which chemical functional group is characteristic of cellulose acetate membranes and renders them susceptible to hydrolysis at high and low pH?
(A) Amide bonds
(B) Ether linkages
(C) Sulfonyl groups
(D) Ester bonds

2007

121. The mass balance around an NF system separating salty whey requires an accounting of which specific variable not typically calculated in standard UF?
(A) Fat content
(B) Passage of monovalent ions
(C) True protein content
(D) Casein micelle size

2005

122. Which process creates whey protein ingredients specifically tailored for formulating clear acidic beverages?
(A) Controlled heat coagulation at pH 4.5 followed by high-speed centrifugation.
(B) Complete demineralization of the liquid stream using industrial electrodialysis.
(C) Microfiltration to remove residual lipids followed by standard ultrafiltration.
(D) Continuous lyophilization of raw sweet whey under deep vacuum and low temperature.

2002

123. Identify the INCORRECT statement regarding the application of UF in cheese manufacture.
(A) The volume of whey produced per vat is drastically reduced.
(B) The retention of whey proteins contributes to increased cheese yield.
(C) Soft cheeses like Feta and Camembert have been successfully commercialized using the liquid pre-cheese concept.
(D) UF retentate coagulates much slower than unconcentrated milk, requiring more rennet.

2021

124. The use of an enzymatic membrane reactor for processing ultrafiltration permeate primarily involves which action?
(A) Lactose hydrolysis by active enzymes (such as lactase) retained by the membrane while allowing hydrolyzed monosaccharides to pass in the permeate.
(B) Microbial fermentation of lactose to lactic acid under anaerobic conditions.
(C) Physical concentration and crystallization of lactose from the permeate stream without chemical change.
(D) Continuous sterilization of the final permeate stream utilizing ultraviolet light.

2018

125. Given below are two statements, one labeled as Assertion (A) and the other labeled as Reason (R):
Assertion (A): Microfiltration membranes are highly effective in selectively separating casein micelles from whey proteins in skim milk.
Reason (R): Casein micelles exist primarily in the size range of 0.05 to 0.3 micrometers, whereas native whey proteins are significantly smaller.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2024

126. During the enzymatic cleaning of a UF membrane fouled by whey, what type of enzyme is strictly required?
(A) Lipase
(B) Protease
(C) Lactase
(D) Amylase

2010

127. Which principle underlies the effectiveness of Uniform Transmembrane Pressure (UTMP) systems?
(A) Pumping permeate concurrently with retentate flow to maintain a constant pressure differential.
(B) Increasing the feed pressure up to 100 bar to force uniform distribution across the system.
(C) Completely stopping cross-flow circulation to allow the internal pressure to equalize naturally.
(D) Installing distinct membranes of varying nominal pore sizes along the length of the module.

2013

128. What distinguishes Milk Protein Isolate (MPI) fundamentally from a co-precipitate of milk proteins?
(A) MPI is manufactured using advanced membrane filtration, whereas co-precipitates rely on thermal and acidic denaturation.
(B) MPI contains only highly purified micellar

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2024

112. The specific application of ultrafiltration to adjust the protein level of fluid milk for standardization ensures compliance with which regulatory framework principle?

(A) Complete substitution of milk fat with vegetable oils
(B) Strict prohibition of any water addition to milk
(C) Permitted addition of synthetic food thickeners
(D) Maintenance of the natural protein ratio

2011

113. What phenomenon occurs if the applied transmembrane pressure in a reverse osmosis process is less than the osmotic pressure of the feed solution?

(A) Forward osmosis occurs, drawing water to the feed.
(B) Solutes pass through the membrane without water molecules
(C) Reverse osmosis proceeds normally but at a slower rate
(D) The membrane pores permanently and irreversibly close

2007

114. Which metric is used to evaluate the efficiency with which a cleaning cycle removes protein fouling from an ultrafiltration membrane?

(A) The measurement of retentate sweetness
(B) The visual color of the membrane module housing
(C) The restoration of pure water flux
(D) The change in power consumption of the feed pump

2005

115. Consider the following statements regarding inorganic membranes:

I. Alumina membranes exhibit excellent resistance to abrasive particulate matter.
II. Zirconia is rarely used because it easily dissolves in alkaline cleaning solutions.
III. Ceramic membranes can tolerate steam sterilization at 121°C.

Which of the above statements are correct?

(A) I and II
(B) I and III
(C) II and III
(D) I, II and III

2014

116. How does the structure of a hollow fiber membrane differ fundamentally from a tubular membrane?

(A) Hollow fibers have the active skin layer on the outside, whereas tubular membranes always have it on the inside.
(B) Hollow fibers are exclusively manufactured from ceramic materials.
(C) Hollow fibers cannot be operated in a cross-flow configuration.
(D) Hollow fibers are self-supporting capillaries with much smaller diameters, leading to higher packing density.

2022

117. What is a primary limitation of using a spiral-wound module for processing high-viscosity concentrated dairy products?

(A) Feed spacers are easily blocked by particulates or highly viscous retentate.
(B) The spiral flow channels inherently lower the membrane's rejection coefficient.
(C) The complex housing makes them more expensive than plate-and-frame systems.
(D) The design requires specialized ceramic membrane structures to function.

2017

118. In multi-stage plant design, what characterizes a "Christmas tree" layout commonly used in reverse osmosis plants?

(A) The system operates exclusively during cold seasons to naturally control feed water temperatures.
(B) High-purity permeate from the final processing stage is recycled back into the initial feed stream.
(C) Parallel pressure vessels decrease in successive stages to maintain optimal cross-flow velocity.
(D) Multiple membrane modules are arranged vertically to utilize natural gravitational force for flow.

2023

119. A dairy plant requires the removal of somatic cells and bacteria from skim milk with minimal loss of casein. Which pore size range is optimal?

(A) 0.001 to 0.01 micrometers
(B) 0.1 to 0.5 micrometers
(C) 1.2 to 1.4 micrometers
(D) 10 to 20 micrometers

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(D) P-1, Q-4, R-2, S-3

2011

136. Which membrane material is generally most susceptible to swelling and irreversible degradation by trace amounts of free chlorine in wash water?
(A) Zirconia
(B) Cellulose acetate
(C) Polysulfone
(D) Polyamide

2003

137. The concentration of skim milk via RO is practically limited to what maximum total solids content before osmotic pressure and viscosity become prohibitive?
(A) 12-15 percent
(B) 25-30 percent
(C) 50-60 percent
(D) 80-90 percent

2022

138. What is the defining physical property of an ideal semi-permeable membrane in reverse osmosis?
(A) It contains distinct, highly structured macropores that are easily visible under a light microscope.
(B) It completely dissolves in the incoming feed solution and spontaneously reforms on the permeate side.
(C) It functions through a solution-diffusion mechanism rather than convective flow through distinct pores.
(D) It actively pumps water molecules against the concentration gradient utilizing external electrical energy.

2014

139. In predicting permeate flux dynamics using the resistance-in-series model, total resistance (R_t) is calculated as the sum of which components?
(A) Hydrodynamic resistance, thermal resistance, electrical resistance, and convective resistance.
(B) Osmotic flow resistance, gel layer resistance, vapor pressure, and feed viscosity resistance.
(C) Retentate boundary resistance, permeate channel resistance, and spacer friction resistance.
(D) Membrane resistance, fouling resistance, and concentration polarization resistance.

2025

140. Which factor provides the greatest advantage to using a plate-and-frame module over a spiral-wound module in a heavily fouling dairy stream?
(A) The open channel design of plate-and-frame modules accommodates higher viscosities and particulate loads without catastrophic plugging.
(B) Plate-and-frame modules exhibit a significantly higher packing density per cubic meter of space compared to spiral systems.
(C) Plate-and-frame modules utilize advanced design modifications to completely prevent concentration polarization during runs.
(D) Plate-and-frame modules are engineered to operate efficiently without requiring any cross-flow velocity across the surface.

2023

141. Identify the primary physical reason why permeate flux eventually stabilizes at a constant value despite further increases in transmembrane pressure in ultrafiltration.
(A) The high-pressure feed pump reaches its mechanical RPM limit and cannot deliver any additional volumetric flow.
(B) The gel layer reaches its maximum concentration, causing its specific resistance to increase proportionally with pressure.
(C) The pores of the polymeric membrane physically compress and close completely under the influence of higher operating pressure.
(D) The localized osmotic pressure of the concentrated boundary layer begins to completely reverse the flow of the permeate.

2009

142. The "Molecular Weight Cut-Off" (MWCO) of a membrane is not a strictly absolute barrier because:
(A) Dissolved solute molecules are always perfectly spherical and completely rigid under high-pressure processing conditions.
(B) Rejection is strongly influenced by molecular shape, structural flexibility, and specific membrane surface interactions.
(C) Polymeric membranes slowly dissolve during routine operation, which gradually enlarges the physical dimensions of the pores.
(D) Extremely high cross-flow velocity physically pushes all solute molecules through the barrier regardless of their size.

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2008

143. Which membrane configuration features the unique capability of back-pulsing to maintain permeate flux?
(A) Ceramic tubular
(B) Spiral-wound polymeric
(C) Hollow fiber polymeric
(D) Plate-and-frame polymeric

2013

144. How does the incorporation of ultrafiltered retentate specifically alter the sensory properties of traditional shrikhand?
(A) It alters the physical structure, rendering the final product completely liquid at room temperature.
(B) It introduces a highly noticeable burnt off-flavor due to the rapid concentration of active lactose.
(C) It creates a smoother, more uniform texture and richer mouthfeel due to retained whey proteins.
(D) It triggers rapid fermentation, leading to extremely high sourness and acid production within minutes.

2024

145. Arrange the processes by the typical magnitude of operating pressure required, from lowest to highest.
I. Microfiltration
II. Reverse Osmosis
III. Ultrafiltration
IV. Nanofiltration
(A) I, III, IV, II
(B) III, I, IV, II
(C) I, IV, III, II
(D) II, IV, III, I

2006

146. A dairy plant produces WPC-80 from cheese whey. What is the most critical process control parameter required to achieve this specific protein concentration?
(A) The temperature of the incoming feed whey must be maintained strictly at exactly 4°C.
(B) The systematic deployment of reverse osmosis treatment prior to entering the ultrafiltration stage.
(C) The precise implementation of diafiltration to wash out residual lactose and minerals.
(D) The continuous addition of highly concentrated calcium chloride directly to the incoming feed whey.

2016

147. Which intrinsic property of whey proteins is exploited when utilizing ultrafiltration for their recovery from cheese whey?
(A) Their exceptionally high lipid concentration and hydrophobic surface properties.
(B) Their relatively large molecular size compared to lactose and water molecules.
(C) Their unique ability to crystallize rapidly when exposed to extremely low temperatures.
(D) Their extreme thermodynamic volatility when processed under deep industrial vacuum.

NODIA

2007

148. What is the primary environmental benefit of deploying Reverse Osmosis (RO) to process dairy plant effluents?
(A) It generates highly purified, crystalline lactose structures directly from the wastewater stream.
(B) It instantly sterilizes the entire volume of effluent by physically killing all bacterial pathogens.
(C) It biochemically converts residual milk fat fractions into highly combustible methane-rich biogas.
(D) It significantly reduces the Biological Oxygen Demand of the discharged water by retaining organics.

2013

149. In the context of dairy membrane fouling, "concentration polarization" occurs precisely at which spatial location?
(A) Within the boundary layer immediately adjacent to the membrane surface.
(B) Throughout the entirety of the moving bulk retentate stream.
(C) Directly inside the centralized permeate collection tube.
(D) Exclusively within the high-pressure feed pump casing.

2018

150. Which analytical test is most appropriate to verify the complete removal of cleaning chemicals from a membrane plant post-CIP?
(A) Measuring the total residual protein content of the rinse water.
(B) Checking the visual transparency and turbidity of the permeate.
(C) Measuring the pH and conductivity of the final rinse water.
(D) Determining the exact freezing point

depression of the rinse water.

2013

151. Why is uniform transmembrane pressure (UTMP) especially critical in microfiltration systems designed for fractionating milk proteins?
(A) High inlet pressures force casein micelles into membrane pores, causing irreversible internal fouling.
(B) Without UTMP, native whey proteins undergo rapid heat denaturation and precipitate out of solution immediately.
(C) The implementation of UTMP completely eliminates the operational need for cross-flow velocity in the system.
(D) It functions as a specialized hydraulic safety valve to prevent the primary feed pump from cavitating.

2001

152. Identify the INCORRECT statement concerning specific membrane materials.
(A) Polysulfone membranes are highly robust and can generally tolerate pH levels from 1 to 13.
(B) Ceramic membranes exhibit a naturally hydrophilic surface that resists severe organic fouling.
(C) Polyamide membranes are widely recognized for providing exceptional rejection of sodium chloride.
(D) Cellulose acetate membranes are robust against biological degradation by cellulase enzymes.

2003

153. What is the fundamental difference between Milk Protein Concentrate (MPC) and Whey Protein Concentrate (WPC) regarding their behavior in rennet coagulation?
(A) WPC coagulates much faster than MPC during processing due to high beta-lactoglobulin concentration.
(B) MPC coagulates with rennet because it contains native micellar casein, whereas WPC does not.
(C) Both protein streams will coagulate equally well under the direct enzymatic action of rennet.
(D) Neither stream coagulates because membrane pressure completely destroys native rennet reactivity.

2001

154. What defines the isoelectric point (pI) of a protein, a crucial concept in predicting membrane fouling behavior?
(A) The pH value at which the target protein possesses its maximum possible net negative electrical charge.
(B) The critical temperature threshold at which the protein structure completely denatures and precipitates.
(C) The pH where the protein has a net charge of zero, typically resulting in minimum solubility.
(D) The specific minimum concentration threshold at which the protein molecules spontaneously form a gel.

2017

155. Consider the following statements about Reverse Osmosis and Nanofiltration:
I. RO permeate is generally considered pure water suitable for reuse as boiler make-up.
II. NF operates based purely on a size-exclusion mechanism, ignoring solute charge.
III. The osmotic pressure of whey increases exponentially as it is concentrated by RO.
IV. NF is highly effective for reducing the ash content of salty whey.
Which of the above statements are correct?
(A) I, II, and III
(B) I, III, and IV
(C) II, III, and IV
(D) I, II, and IV

2006

156. In a continuous membrane plant, the "Volume Concentration Factor" (VCF) is most accurately determined by which ratio under steady-state conditions?
(A) Feed flow rate divided by retentate flow rate
(B) Retentate flow rate divided by permeate flow rate
(C) Permeate volume divided by total processing time
(D) Feed volume divided by the sum of retentate and permeate volumes

2014

157. Which process parameter must be strictly monitored to avoid "calcium bridging," a phenomenon where calcium ions link proteins to the membrane surface causing severe fouling?
(A) Retentate Brix level
(B) Feed pH and temperature
(C) Surrounding atmospheric pressure

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2015

94. Cheese yield optimization through ultrafiltration is primarily attributed to the retention of which milk component that is normally lost in whey?
(A) Lactose
(B) Lactic acid
(C) Whey proteins
(D) Monovalent salts

2014

95. Identify the correct option after analyzing the given assertion (A) and reason (R).
Assertion (A): The use of highly concentrated liquid pre-cheese retentate is ideal for hard cheese varieties like Cheddar.
Reason (R): Hard cheeses require extensive moisture removal, which is difficult to achieve uniformly from fully concentrated pre-cheese curds.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2019

96. Rheological improvement of yogurt manufactured using ultrafiltered milk is characterized by which physical attribute?
(A) Increased tendency for whey separation
(B) Lowered viscosity leading to a highly fluid product
(C) Coarse texture due to oversized fat globules
(D) Decreased syneresis and a firmer gel structure

2018

97. The continuous mechanized production of chakka (a concentrated yogurt product) using ultrafiltration replaces which traditional step?
(A) Hanging the curd to drain whey
(B) Boiling of milk at high temperatures
(C) Addition of active starter culture
(D) Addition of refined white sugar

2012

98. When formulating a paneer base using UF retentate, what specific processing challenge must be managed regarding the retentate properties?
(A) Preventing the retentate from freezing at room temperature
(B) Ensuring the complete removal of all milk fat components
(C) Managing high retentate viscosity
(D) Counteracting the spontaneous sweetening of the retentate

2002

99. Which of the following traditional dairy products is least likely to benefit from the direct incorporation of RO-concentrated milk due to flavor implications from retained minerals?
(A) Fluid milk
(B) Sweet Shrikhand
(C) Ice cream mix
(D) Plain yogurt

2007

100. In evaluating membrane processes, which factor determines the boundary layer mass transfer coefficient in the film theory equation $J = k \ln(\frac{C_w}{C_b})$?
(A) The physical dimensions of the permeate collection tank
(B) The chemical composition of the porous membrane support matrix
(C) The absolute amount of dissolved oxygen in the incoming feed
(D) Fluid hydrodynamics and channel dimensions

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2014

101. What is the most significant disadvantage of utilizing a batch membrane processing layout for large industrial applications?
(A) It requires the highest capital investment for process instrumentation
(B) Residence time causes stress on the fluid.
(C) It inherently prevents the use of diafiltration operations
(D) It only operates under conditions of concentration polarization

2007

102. Which variable primarily dictates whether fouling is classified as reversible or irreversible?
(A) The total operational age of the active membrane polymer
(B) The visual color profile of the deposited foulant layer
(C) Ease of removal via physical or chemical cleaning
(D) The exact molecular weight of the retained solutes

2006

103. If the transmembrane pressure is doubled during the mass transfer-controlled regime of ultrafiltration, what is the expected effect on the permeate flux?
(A) The flux will double in direct proportion.
(B) The flux will decrease by exactly one half.
(C) The flux will become completely negative.

Assertion (A): Maintaining a high cross-flow velocity is crucial in tubular membrane modules processing concentrated dairy liquids.
Reason (R): High cross-flow velocity generates shear forces at the membrane wall that continuously sweep away accumulated solutes, mitigating the thickness of the gel layer.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2021
166. Which mathematical metric best describes the percentage of a specific component that successfully passes through the membrane into the permeate?
(A) Retention coefficient
(B) Concentration factor
(C) Transmission coefficient
(D) Diafiltration ratio

2023
167. Identify the most critical limitation of using cellulose acetate membranes in modern dairy processing plants.
(A) They possess a highly restricted operational pH and temperature range, making standard CIP protocols difficult.
(B) They require highly complex, specialized synthetic polymers that are extremely expensive to manufacture.
(C) They exhibit highly hydrophobic surface characteristics, which causes instantaneous protein fouling.
(D) They cannot be physically rolled or manufactured into a standard space-saving spiral-wound configuration.

2025
168. Which component is entirely rejected by a standard Nanofiltration (NF) membrane used in dairy applications?
(A) Water
(B) Sodium ions
(C) Chloride ions
(D) Lactose

2009
169. What functional role does native beta-lactoglobulin play in the heat-induced gelation of Whey Protein Isolate?
(A) It completely prevents the gel network from forming by acting as an active biochemical surfactant.
(B) It unfolds upon heating, exposing free sulfhydryl groups that form cross-links and a robust gel network.
(C) It significantly lowers the freezing point of the liquid solution to induce specialized cold gelation.
(D) It acts as a proteose-peptone that actively digests surrounding proteins to create a smooth texture.

2024
170. Which specific advantage drives the adoption of ceramic membranes for processing high-acid whey streams?
(A) Their structural flexibility and light overall transport weight.
(B) Their unique ability to be chemically dissolved and regenerated.
(C) Their absolute chemical inertness across the entire pH spectrum.
(D) Their exceptionally low initial capital and installation cost.

2015
171. In terms of hydrodynamics, why are turbulence promoters inserted into the flow channels of some membrane modules?
(A) To significantly increase the average boundary layer thickness across the channel.
(B) To minimize the overall hydrodynamic pressure drop across the length of the module.
(C) To trap large particulate physical debris before it can contact the active membrane.
(D) To induce localized vortex shedding, thereby increasing mass transfer away from the surface.

2009
172. When utilizing ultrafiltration for continuous mechanized paneer production, the concentrated milk base requires which subsequent step to form the final product?
(A) Coagulation via the addition of a heated acidulant like citric or lactic acid.
(B) Subjecting the retentate to intense blast freezing followed by slicing.
(C) Extrusion of the warm concentrate directly into a circulating cold water bath.
(D) Directly adding exceptionally high doses of active rennet to trigger coagulation.

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(D) Hydrodynamic forces increase exponentially, which makes the target cross-flow velocity impossible to control.

2015

218. Which statement best defines the physical concept of "tortuosity" in an asymmetric polymeric membrane?

(A) The total density representing the exact number of active pores per square meter of surface.

(B) The mechanical tendency of a polymeric membrane to physically twist inside the module housing.

(C) The ratio of actual pore channel length to membrane thickness, indicating path complexity.

(D) The specific chemical measure of the active polymer's long-term resistance to free chlorine.

2024

219. The formulation of specialized low-lactose milk powders often relies on a combination of membrane processing and enzymatic hydrolysis. Why not use enzymatic hydrolysis alone?

(A) Commercial lactase enzymes cannot biochemically function in normal fluid milk without some form of membrane pretreatment.

(B) Standard enzymatic hydrolysis triggers a rapid enzymatic reaction that completely solidifies the milk into a gel.

(C) Enzymatic hydrolysis targets and selectively removes the milk protein fractions rather than the target lactose sugars.

(D) Hydrolysis alone converts lactose to sweeter glucose and galactose, whereas UF physically removes sugars to balance flavor.

2008

220. What is the fundamental reason behind the strict limitation of total solids concentration when producing Milk Protein Concentrate (MPC) via ultrafiltration?

(A) Exponential viscosity increases of concentrated casein limit pumpability and reduce flux to near zero.

(B) The heavily concentrated protein retentate eventually undergoes spontaneous combustion inside the pipes.

(C) Concentrated milk fat fractions permanently and irreversibly bind to the stainless steel pipeline walls.

(D) The entirety of the lactose sugar content undergoes instant physical evaporation under high pressure.

2010

221. Which operational parameter must be carefully managed to prevent the phenomenon of "compaction" in polymeric membranes over their lifetime?

(A) Maintaining a consistently high concentration of dissolved lactose sugars throughout the process run.

(B) Avoiding prolonged operation at excessive pressures and high temperatures that compress the polymer.

(C) Ensuring that the primary high-pressure feed pump operates at a very low mechanical RPM during CIP.

(D) Deploying exclusively highly concentrated acidic cleaning chemicals throughout the entire wash cycle.

2002

222. When utilizing ultrafiltration for the continuous production of yogurt bases, how does the process specifically alter the ratio of true protein to non-protein nitrogen (NPN)?

(A) The ratio is inverted, causing low-molecular non-protein nitrogen compounds to become the dominant fraction.

(B) The ratio increases as true proteins are retained while small non-protein nitrogen compounds pass into permeate.

(C) The ratio of true protein to non-protein nitrogen remains completely unchanged from the raw starting milk.

(D) The ultrafiltration process completely and simultaneously removes both true protein and non-protein nitrogen.

2021

223. Identify the key structural advantage of using a ceramic tubular membrane over a spiral-wound membrane in streams with heavy particulate loads.

(A) Ceramic tubular channels are open and linear, lacking feed spacers that physically trap particulates and block flow.

(B) Ceramic membrane matrices contain specialized microscopic dead zones that capture large particulates harmlessly.

(C) Ceramic membrane elements can be easily rolled up and unrolled inside the housing to facilitate manual cleaning.

(D) Ceramic surfaces are engineered to actively repel incoming particulate matter using a

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2002

181. In the production of chakka via ultrafiltration, how is the characteristic sour flavor achieved prior to or during the membrane process?
(A) Fermenting the skim milk with a lactic acid starter culture before or after ultrafiltration.
(B) Directly adding concentrated chemical vinegar or synthetic citric acid to the final retentate.
(C) Allowing the raw milk to undergo natural spontaneous souring at 40°C for three consecutive days.
(D) Running the high-pressure membrane concentration system at a highly acidic pH value of exactly 2.0.

2012

182. Why is the recovery of "cow water" via RO economically critical in large dairy processing facilities?
(A) It extracts the last remaining trace amounts of valuable butterfat from dilute wash waters.
(B) It isolates unique volatile flavor compounds for commercial purification and subsequent resale.
(C) It offsets fresh water intake by providing high-quality reusable water for CIP or boiler feed.
(D) It completely prevents the spontaneous microbial fermentation of organic waste in plant effluents.

2002

183. Which class of protein is predominantly found in the retentate when processing skim milk through a 0.1 micrometer microfiltration membrane?
(A) Micellar casein
(B) Alpha-lactalbumin
(C) Beta-lactoglobulin
(D) Immunoglobulins

2008

184. What is the fundamental challenge of managing calcium phosphate in dairy membrane systems?
(A) Its solubility strictly increases as temperature increases, causing it to crystallize only in the cold sections of the plant.
(B) It rapidly reacts with sodium hydroxide to form a poisonous gas.
(C) It is completely rejected by microfiltration but passes entirely through reverse osmosis.
(D) It exhibits inverse solubility, meaning it tends to precipitate onto the membrane surface at higher processing temperatures.

2013

185. Consider the following statements regarding diafiltration:
I. It is mathematically equivalent to diluting the retentate with solvent and re-concentrating it.
II. It effectively removes macromolecules like casein from the retentate.
III. It increases the purity of the retained species by washing out permeable microsolutes.
IV. It requires significant additions of high-quality water, increasing operational costs.
V. It is totally ineffective at removing dissolved minerals.
Which of the above statements are INCORRECT?
(A) I and III
(B) II and V
(C) III and IV
(D) I and IV

2009

186. Which membrane process is characterized by a driving force predominantly generated by applying pressure in the range of 1 to 10 bar to separate macromolecules from solvent?
(A) Reverse Osmosis
(B) Nanofiltration
(C) Ultrafiltration
(D) Electrodialysis

2006

187. What is the defining characteristic of a "gel layer" in the context of ultrafiltration modeling?
(A) A solid layer of pure water ice formed on the surface due to localized freezing point depression.
(B) A protective synthetic coating applied during membrane manufacture to permanently prevent fouling.
(C) A thin film of crystallized lactose molecules that forms on the active skin exclusively at pH 7.0.
(D) A highly concentrated boundary layer of retained macromolecules that exhibits solid-like flow resistance.

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2004

188. How does the choice of membrane configuration affect the overall energy consumption of a continuous cross-flow plant?
(A) Designs requiring high cross-flow velocities, like tubular modules, demand significantly higher pumping energy.
(B) The total mechanical energy consumption remains completely identical and uniform

across all configurations.
(C) Compact spiral-wound modules always consume the most electrical energy due to their highly complex flow paths.
(D) Standard plate-and-frame systems consume the most energy because they require constant, active stream heating.

2018
189. Which property of an ultrafiltered milk retentate requires significant adjustments to the homogenization process in liquid milk production?
(A) The complete physical absence of any milk fat.
(B) The increased viscosity and altered fat-to-protein ratio.
(C) The extreme chemical acidity of the resulting retentate.
(D) The sudden, spontaneous crystallization of lactose sugars.

2023
190. What specific advantage does cold pasteurization of milk via microfiltration offer for the manufacture of premium cheese?
(A) It completely eliminates any industrial need for rennet enzymes by physically shredding the micellar casein.
(B) It removes spore-forming bacteria causing late-blowing defects without heat-denaturing coagulation-active proteins.
(C) It physically and completely removes all lactose molecules, which results in a naturally sweeter curd profile.
(D) It naturally colors the final curd yellow, completely eliminating the standard commercial need for annatto dye.

2018
191. Which variable does the Hagen-Poiseuille equation identify as having an inverse relationship with the volumetric flow rate through a cylindrical pore?
(A) The dynamic viscosity of the fluid
(B) The applied pressure difference
(C) The radius of the pore to the fourth power
(D) The number of pores in the membrane

2016
192. Identify the fundamental limitation of utilizing reverse osmosis for complete milk powder production without the use of an evaporator.
(A) RO permeates completely retain fat, which subsequently prevents efficient moisture evaporation during drying.
(B) The reverse osmosis process chemically degrades all lactose sugars, making the feed completely impossible to dry.
(C) High osmotic pressure of concentrated milk limits total solids to well below spray drying requirements.
(D) RO treatment requires elevated operational temperatures of 150°C, which immediately scorches the fluid milk.

2013
193. Why are turbulence promoters generally incompatible with hollow fiber membrane modules?
(A) Their physical contact chemically degrades and dissolves the delicate synthetic hollow fiber polymer.
(B) They cause the active surfaces of the fibers to spontaneously become hyper-hydrophilic during runs.
(C) They trigger a severe localized pressure drop, causing instantaneous freezing of the permeate stream.
(D) The physical dimensions of the capillary fibers are too small to house any structural inserts.

2011
194. In the formulation of infant formula, whey protein fractions enriched in which specific protein via membrane separation are highly valued to mimic human breast milk?
(A) Beta-lactoglobulin
(B) Bovine serum albumin
(C) Alpha-lactalbumin
(D) Kappa-casein

2004
195. Arrange the following steps sequentially to describe the standard mechanism of membrane fouling during the processing of whey:
I. Consolidation and internal pore blocking
II. Initial adsorption of proteins onto the pristine membrane surface
III. Formation of a concentration polarization boundary layer
IV. Development of a dense gel layer on top of the adsorbed proteins
(A) III, II, IV, I
(B) II, III, IV, I
(C) II, IV, III, I
(D) III, IV, II, I

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2001

196. Which operational strategy best addresses the issue of high retentate viscosity at the final stage of a multi-stage ultrafiltration plant?

(A) Drastically lowering the operating temperature to increase the overall density of the retentate.

(B) Decreasing the cross-flow velocity to minimize shear-induced denaturation of sensitive proteins.

(C) Adding massive amounts of solid sodium chloride directly to the loop to break the viscous gel.

(D) Operating final stages at a slightly higher temperature within protein stability limits to lower viscosity.

2001

197. What defines "true fouling" as opposed to reversible concentration polarization?

(A) True fouling involves physiochemical interactions like adsorption that require chemical cleaning to remove.

(B) True fouling can be entirely eliminated simply by dropping the operating transmembrane pressure to zero.

(C) True fouling is a highly specific phenomenon that only happens in reverse osmosis, never in ultrafiltration.

(D) True fouling is characterized by a steady, long-term increase in the overall permeate flux rate over time.

2006

198. Which chemical parameter of the feed water must be tightly controlled to prevent premature failure of polyamide RO membranes during standard operation?

(A) Total dissolved lactose concentration.

(B) The overall concentration of beta-carotene.

(C) The presence of free chlorine or strong oxidizers.

(D) The mass ratio of micellar casein to whey.

2014

199. What distinguishes a Milk Protein Concentrate (MPC) containing 85% protein from one containing 50% protein in terms of functional application?

(A) MPC-85 provides a highly concentrated protein source with minimal lactose, making it ideal for low-carbohydrate nutritional formulations and adult nutrition powders.

(B) MPC-85 contains significantly higher levels of active lactose, making it better for fast browning reactions.

(C) MPC-85 is completely insoluble in water across all standard temperature and pH ranges used in processing.

(D) MPC-50 is characterized by the complete absence of any native micellar casein structures in its composition.

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2005

200. In evaluating membrane performance, the term "permeate flux" is defined by which specific units?

(A) Kilograms per cubic meter ($kg \cdot m^{-3}$)

(B) Pascals per second ($Pa \cdot s^{-1}$)

(C) Moles per liter ($mol \cdot L^{-1}$)

(D) Liters per hour per square meter ($L \cdot h^{-1} \cdot m^{-2}$)

2011

201. Which membrane separation process relies on electrical potential rather than hydrostatic pressure to drive the transport of ions?

(A) Reverse Osmosis

(B) Electrodialysis

(C) Nanofiltration

(D) Microfiltration

2002

202. The production of High-Protein Isolates using membranes directly impacts the environment by generating which prominent byproduct that requires further management?

(A) Large volumetric quantities of pure, unseparated milk fat.

(B) Solid, insoluble blocks of pure crystalline calcium phosphate.

(C) Substantial quantities of dilute permeate containing lactose and minerals.

(D) Large volumes of volatile exhaust gases highly rich in free ammonia.

2017

203. Which specific physical attribute of a spiral-wound module makes it vulnerable to catastrophic biological fouling if not properly sanitized?

(A) The organic ceramic matrix provides an exceptionally sticky surface that promotes rapid bacterial attachment.

(B) The polymeric active skin layer chemically absorbs nutrient sugars and actively feeds invading bacteria.

(C) The module operates exclusively at 37°C, which matches the ideal growth temperature for clinical pathogens.

(D) The tight mesh of feed spacers creates

2015

173. What is the fundamental mechanism allowing reverse osmosis to recover pure water from milk?

(A) Applying a continuous high voltage field to selectively pull water molecules through.

(B) Applying a hydraulic pressure that exceeds the inherent osmotic pressure of the milk.

(C) Initiating the rapid structural freezing and subsequent sublimation of the raw milk.

(D) Utilizing specialized metabolic enzymes to break down complexed bound water molecules.

2013

174. Which of the following is considered an intrinsic property of the membrane rather than an operational parameter?

(A) Transmembrane pressure

(B) Molecular Weight Cut-Off (MWCO)

(C) Cross-flow velocity

(D) Feed temperature

2004

175. Match the membrane module characteristics in List I with their correct configurations in List II:

List I: (Module Characteristic)

P. Lowest capital cost per square meter

Q. Requires UTMP to prevent inlet fouling

R. Highest physical resistance to particulate plugging

S. Active skin layer on the outside of fine capillaries

List II: (Configuration)

1. Ceramic Tubular
2. Spiral-wound
3. Hollow fiber
4. Plate-and-frame (open channel)

(A) P-2, Q-1, R-4, S-3

(B) P-1, Q-2, R-3, S-4

(C) P-3, Q-4, R-1, S-2

(D) P-4, Q-3, R-2, S-1

2009

176. Which condition represents the concept of a "feed-and-bleed" configuration operating at steady state?

(A) The feed tank is completely emptied of all fluid before the next fresh batch is introduced.

(B) The internal cross-flow velocity steadily drops to zero due to continuous pressure equalisation.

(C) Loop retentate concentration remains constant and equal to the final desired product concentration.

(D) The system relies entirely on forward osmosis driven by a concentrated salt draw solution.

2021

177. Identify the correct pair describing a cleaning agent and its specific target foulant in a dairy membrane.

(A) Nitric acid - Denatured whey protein precipitates

(B) Protease enzyme - Insoluble calcium phosphate scale

(C) Hydrogen peroxide - Emulsified free fat residues

(D) Sodium hydroxide - Adsorbed beta-lactoglobulin

2003

178. What determines the osmotic pressure of a dairy fluid according to the van't Hoff equation?

(A) The average dynamic viscosity of the liquid feed.

(B) The physical shape and size of the suspended particles.

(C) The total molar concentration of all dissolved solute particles.

(D) The specific light absorption and color intensity of the fluid.

2022

179. If a membrane system demonstrates a severe and sudden drop in rejection coefficient along with an unexpected increase in permeate flux, what is the most likely cause?

(A) Severe and extreme concentration polarization at the surface.

(B) A physical breach or rupture in the membrane surface or seals.

(C) The formation of an exceptionally thick macromolecular gel layer.

(D) The complete volumetric depletion of the incoming feed liquid.

2007

180. Which process enables the production of a Whey Protein Isolate (WPI) powder containing negligible lactose?

(A) Extended single-pass ultrafiltration processing.

(B) High-temperature industrial reverse osmosis.

(C) Microfiltration with a 1.4 micrometer membrane.

(D) Ultrafiltration followed by extensive diafiltration.

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(D) MF strictly requires an external electrical potential, whereas UF runs purely on hydrostatic pressure.

2011

211. In the mathematical calculation of Volume Concentration Factor (VCF), if a process has a feed volume of 5000 L and produces 4000 L of permeate, what is the VCF?
(A) 1.25
(B) 4
(C) 5
(D) 10

2018

212. Which condition must be met to maximize the efficiency of a diafiltration process in terms of water consumption?
(A) Adding all required diawater to the initial dilute feed stream before any filtration begins.
(B) Performing the entire diafiltration process exclusively at extremely low temperatures near 0°C.
(C) Utilizing highly mineralized industrial hard water as the primary source of incoming diawater.
(D) Adding diawater continuously to match permeate flux, maintaining a constant minimum retentate volume.

2019

213. What is the fundamental principle behind using microfiltration to remove bacteria from milk prior to cheese making?
(A) Bacteria are larger than the membrane pores and are retained, while soluble proteins pass through.
(B) Bacteria undergo rapid chemical degradation and cell lysis upon touching the active surface.
(C) The microfiltration process incorporates high-intensity ultraviolet light to sterilize permeate.
(D) The active polymeric membrane selectively binds specifically to bacterial genomic DNA strands.

2024

214. Which specific attribute of Whey Protein Isolate (WPI) makes it highly desirable for high-protein clear sports drinks?
(A) Its absolute insolubility at pH 4.6
(B) Its high opacity and white color
(C) Its exceptional solubility and clarity at low pH (pH 3.0 - 3.5)
(D) Its strong capacity to form solid, irreversible gels at room temperature

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2004

215. Consider the following statements about process design and plant layouts:
I. A batch processing design subjects the fluid to longer total residence times and mechanical shear.
II. Continuous multi-stage systems provide tighter residence time distributions and gentler handling of the product.
III. Feed-and-bleed systems do not utilize recirculation loops.
IV. Single-pass systems are only practical when very high VCFs are achieved instantly, which is rare in standard dairy UF.
Which of the above statements are correct?
(A) I, II, and III
(B) II, III, and IV
(C) I, II, and IV
(D) I, III, and IV

2003

216. How does the concept of 'molecular weight cut-off' fail to precisely predict the rejection of linear, highly flexible polymer chains?
(A) Flexible polymer chains always rapidly compress into perfectly rigid spheres under high pressure.
(B) Highly flexible chains instantly block all available active surface pores, completely halting flow.
(C) The nominal MWCO physical metric only applies to simple inorganic mineral ions and water molecules.
(D) Flexible chains may uncoil and snake through pores smaller than their nominal spherical diameter.

2005

217. In the context of dairy processing, what is the most significant obstacle to operating a membrane system at extremely high temperatures (e.g., >65°C)?
(A) The overall viscosity of the hot milk drops too low, which prevents the feed pump from developing pressure.
(B) High rates of irreversible calcium phosphate precipitation and thermal denaturation of sensitive whey proteins.
(C) The entirety of the lactose content instantly converts into organic lactic acid at these high temperatures.

2015

230. The integration of ultrafiltration in cheese manufacturing has revolutionized the industry. What is the defining characteristic of a cheese made entirely from a "fully concentrated liquid pre-cheese" retentate?

(A) It requires the final packaged cheese to be aged in deep cold storage for exactly ten years.

(B) It necessitates the complete and absolute removal of all milk fat prior to membrane processing.

(C) It generates absolutely no liquid whey drainage from vats during coagulation and molding steps.

(D) It strictly utilizes non-bovine milk sourced exclusively from small ruminants like goats or sheep.

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strong static electric charge.

2013

224. What is the specific role of the 'support layer' in a thin-film composite (TFC) reverse osmosis membrane?

(A) To provide the highly selective, ultra-thin semi-permeable barrier that controls solute and solvent transport.

(B) To generate an active electrical charge field that electrostatically repels passing multivalent mineral ions.

(C) To provide robust mechanical strength to withstand high operating pressures without impeding permeate flow.

(D) To actively absorb free chlorine and strong chemical oxidizers before they can damage the primary active layer.

2017

225. Consider the following statements concerning the mechanisms of membrane fouling:

I. Irreversible fouling physically alters the internal pore structure of the membrane.

II. Concentration polarization is an entirely thermodynamic and fluid-dynamic phenomenon.

III. Calcium phosphate fouling exhibits inverse solubility, meaning it worsens at higher processing temperatures.

IV. Adsorption of proteins occurs instantly upon contact with the membrane, even before pressure is applied.

V. Back-pulsing is highly effective at reversing long-term chemical adsorption.

Which of the above statements are INCORRECT?

(A) I and II

(B) III and IV

(C) Only V

(D) II and V

2012

226. In terms of mass transfer mechanics, how does an increase in the bulk feed temperature theoretically affect the permeate flux, assuming fouling is constant?

(A) It decreases overall flux rates by significantly increasing the dynamic fluid viscosity of the feed.

(B) It has absolutely no theoretical or physical effect on the rate of mass transfer across the barrier.

(C) It increases flux by decreasing fluid viscosity and increasing the solute diffusion coefficient.

(D) It completely reverses the physical flow direction, spontaneously triggering high-rate forward osmosis.

NODIA

2023

227. Which specific processing challenge arises when concentrating native micellar casein via microfiltration compared to standard ultrafiltration of skim milk?

(A) Microfiltration treatment completely and irreversibly denatures the structure of casein micelles.

(B) The required pore size allows passage of small casein micelles, reducing overall casein yield.

(C) The minimum operating pressure required is over 100 bar, which far exceeds standard UF systems.

(D) The microfiltration process inherently adds massive and undesirable amounts of sodium to the product.

2010

228. How does the application of Reverse Osmosis (RO) specifically benefit the transportation economics of fluid whey?

(A) By completely converting liquid whey into a stable, dry solid powder directly on-site using thermal energy.

(B) By removing all heavy minerals, allowing the remaining liquid whey to be safely discharged into local streams.

(C) By biochemically fermenting lactose into highly valuable industrial alcohol fractions before shipping.

(D) By increasing total solids, reducing the volume of water that must be trucked to central facilities.

2004

229. Which principle explains why a small amount of transmembrane pressure is maintained during the rinse steps of a CIP cycle?

(A) To force clean rinse water through membrane pores, purging chemical residues from the permeate side.

(B) To ensure that the rinse water aggressively scrubs and cleans the bulk retentate channel walls.

(C) To chemically neutralize any remaining highly active acid or alkali residues inside the module.

(D) To rapidly cool the hot polymeric membrane down to safe, near-freezing baseline temperatures.

physical dead zones where bacteria easily hide and form biofilms.

2017

204. Identify the consequence of operating a nanofiltration system with an excessively high recovery rate (retentate concentration).

(A) Rejected salts at the membrane surface will exceed their solubility limits, causing rapid inorganic scaling.

(B) The active semi-permeable barrier will undergo physical changes and begin to reject water molecules entirely.

(C) The nominal pore sizes of the polyamide layer will mechanically stretch into the microfiltration range.

(D) The collected liquid permeate will spontaneously crystallize into pure, highly concentrated lactose sugars.

2015

205. Consider the following statements about membrane applications for traditional dairy products:

I. Ultrafiltration allows for continuous production of shrikhand base by directly concentrating skim milk prior to fermentation.

II. The use of UF in paneer production results in a product with identical rheology to traditionally manufactured paneer.

III. Incorporating UF retentates in yogurt manufacturing eliminates the need to add skim milk powder to increase total solids.

Which of the above statements are correct?

(A) I and II

(B) I and III

(C) II and III

(D) I, II and III

2013

206. Which factor is most directly responsible for the superior solubility of native micellar casein isolated via microfiltration compared to acid casein?

(A) The entire filtration and isolation process occurs at exceptionally high operating temperatures.

(B) The isolation avoids isoelectric precipitation, which irreversibly collapses micellar structure.

(C) Microfiltration chemically modifies the casein protein surface by introducing hydrophilic hydroxyl groups.

(D) Native micellar casein isolated this way completely lacks any bound calcium or phosphorus minerals.

2011

207. What characterizes the specific flow regime generated by turbulence promoters inside a tubular module?

(A) Eddy currents and localized mixing near the boundary layer.

(B) Perfect, undisturbed laminar flow throughout the channel.

(C) Complete hydrodynamic stagnation of the moving retentate.

(D) A total, spontaneous reversal of overall flow direction.

2002

208. During the CIP of an ultrafiltration plant processing milk, an acidic wash step fails to remove an accumulated foulant. A subsequent alkaline wash removes it immediately. What was the most likely foulant?

(A) Calcium phosphate scale

(B) Residual free chlorine

(C) Adsorbed protein layer

(D) Fine silica sand

2021

209. What happens to the retention coefficient of low molecular weight solutes during the extended diafiltration of whey?

(A) It shifts directly to 1.0 because the high pressure causes membrane pores to shrink.

(B) It becomes negative, causing the low molecular weight solute to concentrate in the retentate.

(C) It fluctuates unpredictably depending on the total volume of fresh diawater added to the loop.

(D) It remains near zero, allowing continuous washout of the target solute until depletion.

2021

210. Which statement most accurately compares microfiltration (MF) and ultrafiltration (UF) in terms of target separation components in milk?

(A) MF separates soluble minerals from lactose, whereas UF selectively isolates fat globules from water.

(B) Both operations are identical in their target components but run at drastically different temperatures.

(C) MF targets fat globules, bacteria, and large casein, while UF targets dissolved whey proteins.

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ANSWERS

1. (A) Transmembrane pressure
Microfiltration and ultrafiltration are pressure-driven membrane separation processes. The mechanical pressure differential applied across the membrane, known as transmembrane pressure, forces the solvent and small solutes through the barrier while larger molecules are retained. This hydrostatic pressure difference overcomes flow resistance and drives the convective mass transport of fluid through the membrane pores.

2. (C) van't Hoff equation
The van't Hoff equation is a classic thermodynamic model used to calculate the osmotic pressure of dilute, ideal solutions. It establishes a direct linear relationship between osmotic pressure, solute molar concentration, absolute temperature, and the universal gas constant. This model is highly useful in reverse osmosis and nanofiltration design for estimating back-pressure requirements.

3. (A) Transmembrane pressure
Transmembrane pressure is the average pressure differential across a membrane module, calculated from the average of the feed and retentate pressures minus the permeate pressure. This dynamic parameter represents the net driving force driving fluid permeation. Properly balancing these system pressures is critical for managing flux, controlling concentration polarization, and minimizing fouling during filtration.

4. (D) It describes the selective transport of molecules based on size, shape, and charge.
Semi-permeability defines the selective transport behavior of a membrane, allowing specific components to pass through while retaining others. This separation mechanism depends on multiple physical and chemical interactions, including steric hindrance based on molecular size and shape, as well as electrostatic interactions based on surface charge, which collectively determine retention behavior in industrial membrane systems.

5. (A) I and II
Reverse osmosis requires applied hydrostatic pressure to exceed the natural osmotic pressure of the solution to force water through the membrane. This osmotic pressure is theoretically calculated using the van't Hoff equation under the assumption of ideal thermodynamic behavior. Conversely, pressure-driven separations rely on hydrostatic pressure differences, not concentration gradients, as their primary separation driver.

6. (C) Transmembrane pressure
Darcy's law is a fundamental equation describing fluid flow through porous media, stating that the permeate flux is directly proportional to the applied transmembrane pressure. Conversely, the flux remains inversely proportional to fluid viscosity and the total hydraulic resistance of the system. This linear relationship forms the basis for estimating clean water flux in membrane modules.

7. (D) It models fluid flow through cylindrical pores of uniform radius.
The Hagen-Poiseuille equation models laminar fluid flow through circular tubes, and in membrane science, it is adapted to estimate flux through porous membranes. By treating membrane structures as collections of parallel, cylindrical pores of uniform radius, the model relates fluid velocity directly to pore dimensions, viscosity, pore density, and applied pressure drop across the barrier.

8. (B) MF, UF, NF, RO
Pressure-driven membrane systems are classified by their pore size and required operational pressures. Microfiltration utilizes the largest pores and lowest pressures, followed by ultrafiltration, then nanofiltration. Reverse osmosis, having the tightest structure, operates at the highest pressures to overcome significant osmotic back-pressure, establishing the order of microfiltration, ultrafiltration, nanofiltration, and finally reverse osmosis.

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66. (C) Whey Protein Isolate (WPI)
Diafiltration is required to produce high-purity protein ingredients like Whey Protein Isolate. By adding water to the retentate during ultrafiltration, low molecular weight impurities such as lactose and minerals are washed out through the membrane while proteins are retained, allowing the protein concentration to exceed ninety percent on a dry matter basis.

67. (A) Reverse osmosis water
Purified water, typically produced via reverse osmosis, is continuously or batchwise added to the retentate stream during diafiltration. This addition dilutes the concentrated retentate and maintains its volume, allowing small permeable solutes like lactose and mineral salts to continue washing through the membrane pores while keeping the viscosity manageable during the purification process.

68. (D) Lactose and soluble minerals
The mechanism of diafiltration washes out low molecular weight, membrane-permeable solutes from the retentate. Adding wash water dilutes the concentration of lactose, soluble mineral salts, and non-protein nitrogen compounds in the serum, which then pass through the membrane pores, significantly increasing the relative concentration of retained macromolecular proteins in the final retentate.

69. (B) 1
A diavolume is a dimensionless parameter defined as the total volume of wash water added divided by the volume of the retentate. If the volume of added wash water is exactly equal to the volume of the retentate, this represents exactly one diavolume, which is used to measure wash efficiency during diafiltration.

70. (C) Continuous mode requires less water for the same purification.
Continuous diafiltration, where wash water is added at the same rate as permeate is removed, is mathematically more efficient than batch discontinuous diafiltration. This continuous addition requires significantly less total water to achieve the same target level of purity, reducing wastewater generation, processing times, and subsequent evaporation costs in large-scale dairy operations.

71. (D) Protein
The numerical designation in Whey Protein Concentrate products refers to the minimum percentage of protein contained in the final spray-dried powder on a dry weight basis. Therefore, Whey Protein Concentrate 34 indicates that the powder contains thirty-four percent protein, with the remaining fraction consisting of lactose, fat, moisture, and minerals.

72. (A) Ultrafiltration
Ultrafiltration is the key membrane separation technology used to manufacture Whey Protein Concentrate from sweet whey. By selecting an appropriate molecular weight cut-off, typically around ten kilodaltons, ultrafiltration membranes retain valuable whey proteins while allowing lactose, minerals, and water to pass into the permeate, concentrating the protein fraction on a dry basis.

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73. (B) Ultrafiltration and diafiltration
To manufacture Whey Protein Isolate containing over ninety percent protein, a combination of ultrafiltration and diafiltration is necessary. Ultrafiltration concentrates the protein molecules, while subsequent diafiltration washes out residual lactose and minerals from the retentate, increasing the protein-to-total-solids ratio to the high levels required for isolate ingredients.

74. (B) Excessive pressure causes fouling, lowering protein purity.
Excessive transmembrane pressure during ultrafiltration causes rapid compaction of the concentration polarization layer, leading to severe membrane fouling. This fouling increases system resistance, restricts the passage of permeable lactose and minerals, and results in their retention in the retentate, which lowers the protein purity and consistency of the final whey protein ingredients.

75. (A) II, IV, I, III
The manufacturing of Whey Protein Isolate begins with cheese making to separate sweet whey from the curd. This separated whey undergoes microfiltration to remove residual lipids and fat. Next, ultrafiltration and diafiltration concentrate the proteins and wash out lactose and minerals. Finally, the highly purified protein retentate is spray-dried into powder.

18. (C) Superior strength and chemical inertness
Ceramic membranes exhibit outstanding operational longevity due to their superior mechanical strength and complete chemical inertness compared to polymer matrices. These inorganic materials do not suffer from compaction under high pressures, are completely immune to biodeterioration, and tolerate harsh chemical environments and high sanitizing temperatures, resulting in a lifespan often extending several years beyond polymeric membranes.

19. (A) Plate-and-frame module - Easy membrane replacement and visual inspection
Plate-and-frame membrane modules feature a flat-sheet design that allows individual membrane sheets and support plates to be dismantled easily for direct visual inspection, cleaning, or localized replacement. This modular accessibility is a distinct operational advantage over sealed spiral-wound or hollow fiber designs, although plate-and-frame systems offer lower packing densities than modern spiral configurations.

20. (D) Hollow fiber
Hollow fiber modules provide the highest packing density among industrial membrane configurations by packing thousands of microscopic, self-supporting tubular fibers into a single pressure vessel. This design maximizes the available filtration surface area per unit of equipment volume, allowing for highly compact system footprints, although it remains sensitive to clogging by suspended solids and large particulate matter.

21. (B) Ability to process highly viscous particulate fluids
Tubular membrane modules utilize wide flow channels that can successfully process highly viscous dairy liquids containing large suspended solids, aggregates, or particulates without risk of plugging. This robust physical configuration ensures reliable operations when concentrating thick dairy products, though it consumes more pumping energy and offers significantly lower packing densities compared to spiral-wound or hollow fiber modules.

22. (C) To promote turbulence and reduce polarization
Feed spacers are inserted between flat-sheet membrane envelopes in spiral-wound modules to maintain open flow channels and promote local fluid turbulence. This induced mixing enhances the mass transfer coefficient near the membrane surface, significantly reducing concentration polarization and particulate fouling while maintaining uniform flow distribution across the entire length of the wound module during operation.

23. (D) Batch processing system
Batch processing systems are highly suitable for small-scale operations handling limited daily volumes of a single product. In this layout, feed is recycled back to a reservoir tank until the desired target concentration is achieved, offering maximum operational flexibility, low initial capital costs, and simple control schemes, despite subjecting product to longer heat and shear histories.

24. (A) A portion of retentate is recirculated while the rest is continuously drawn off.
A feed-and-bleed configuration is a continuous system where a high-velocity circulation pump recirculates a large portion of the retentate back through the membrane modules. A small fraction of this concentrated stream is continuously bled off as final product while fresh feed is introduced, allowing the system to operate at steady-state concentration and high cross-flow velocities.

25. (A) P-2, Q-4, R-1, S-3
The Volume Concentration Factor compares initial feed volume to final retentate volume. The retention coefficient determines solute rejection based on the ratio of permeate to retentate concentration. The diafiltration ratio measures wash water relative to feed volume, while permeate flux quantifies the volumetric flow rate crossing a unit area of membrane, defining key performance metrics.

26. (B) The feed fluid passes through the module once and retentate is collected.
In a continuous single-pass membrane system, the feed solution travels through the system modules in a single pass without any recirculation of retentate. The target concentration is reached by the end of the line, which minimizes fluid residence time and heat damage to sensitive components, though it requires very long flow paths and large surface areas.

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This flushing step physically displaces and removes loose, non-adherent feed solids and concentrated milk residues from the membrane modules and piping, reducing the organic load and preventing subsequent chemical cleaners from being prematurely depleted or neutralized during operation.

47. (B) Adsorbed proteins and organics
Alkaline cleaning agents, such as sodium hydroxide, are used in cleaning-in-place cycles to remove organic foulants, particularly proteins and fats. The high pH hydrolyzes peptide bonds, breaking down large, insoluble protein molecules into smaller, soluble fragments. It also saponifies fat residues, facilitating their dispersion and removal from the membrane surface.

48. (D) Solubilization of mineral scale
Acidic cleaning steps in membrane sanitation protocols primarily target inorganic mineral fouling, such as calcium phosphate and milkstone. Circulating low-pH solutions, commonly using nitric or phosphoric acid, solubilizes these precipitated mineral scales, breaking down the crystal matrix on the membrane surface and within its pores, restoring the membrane's hydraulic permeability.

49. (A) Cellulose acetate
Cellulose acetate membranes are highly sensitive to extreme pH levels and undergo rapid chemical hydrolysis when exposed to strong alkaline cleaners. Consequently, enzymatic cleaning agents operating under mild, near-neutral pH conditions are preferred to hydrolyze proteins and lipids on these membranes without damaging the delicate polymeric structure or reducing its separation performance.

50. (C) Cleaning solution temperature
Temperature must be strictly controlled during the alkaline cleaning of polymeric membranes to prevent thermal degradation and chemical hydrolysis of the polymer structure. While elevated temperatures enhance cleaning efficiency, exceeding the manufacturer's recommended limits can irreversibly deform the membrane polymer, alter its pore size distribution, or cause physical compaction under operating pressures.

51. (A) Free chlorine
Polyamide thin-film composite reverse osmosis membranes are highly vulnerable to degradation by oxidizing agents such as free chlorine. Even low levels of chlorine exposure cause irreversible chemical halogenation of the aromatic rings in the polyamide structure, breaking polymer chains and destroying membrane integrity, which leads to a severe loss of salt rejection.

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52. (D) Zirconia (Ceramic)
Zirconia ceramic membranes offer the highest chemical and thermal stability among modern membrane materials. These inorganic structures withstand the entire pH range from zero to fourteen and can tolerate temperatures exceeding one hundred degrees Celsius, permitting aggressive daily sanitization using concentrated chemicals and high-temperature steam without any loss of structural integrity.

53. (B) It degrades into water and oxygen, leaving no residue.
Hydrogen peroxide is an environmentally friendly sanitizing agent that provides broad-spectrum antimicrobial activity by generating free hydroxyl radicals. It is highly valued in dairy applications because it degrades completely into harmless water and oxygen molecules, leaving no chemical residues on the membrane surface or in the processing equipment, simplifying subsequent rinsing cycles.

54. (C) At low pH, the active species is more aggressive toward polymers.
At low pH, chlorine solutions shift to favor hypochlorous acid, a highly active and aggressive oxidizing species that can rapidly attack and degrade polymeric membranes. Therefore, the pH of chlorine-based sanitizers must be maintained within specific alkaline ranges to control oxidation kinetics and prevent polymer degradation while ensuring effective sanitization.

55. (C) A is true but R is false.
Microfiltration is widely used for the cold pasteurization of skim milk because its pore size, typically around one point four micrometers, retains bacterial cells and spores. Conversely, these pores are too large to retain dissolved whey proteins, which pass freely into the permeate along with casein micelles, rendering the explanatory statement false.

56. (A) To remove somatic cells and spores
The primary goal of microfiltration in ESL milk production is the physical removal of

37. (B) Concentration polarization occurs only in dead-end filtration.
Concentration polarization is a reversible phenomenon occurring in both cross-flow and dead-end filtration systems when solutes accumulate near the membrane surface under pressure. In contrast, true membrane fouling involves irreversible processes like pore blocking, scaling, and chemical adsorption of organic molecules, which persist even after the removal of operating pressure and require chemical cleaning.

38. (C) Reversible fouling
Reversible fouling is defined by the loose physical deposition or accumulation of particles on the membrane surface or within its pores without chemical bonding. This foulant layer does not adhere strongly to the membrane and can be easily removed through simple hydraulic actions such as forward flushing, backwashing, or back-pulsing with water.

39. (D) Calcium phosphate
Calcium phosphate is highly notorious for causing severe inorganic scaling, or mineral fouling, on dairy processing membranes. Under elevated temperatures and specific alkaline pH conditions, its solubility decreases, causing rapid precipitation onto the membrane surface and inside the pores. This mineral scale forms a hard layer that restricts flow and requires acidic cleaning solutions to dissolve.

40. (A) The protein's isoelectric point
The isoelectric point of a protein is the pH at which it carries no net electrical charge, which significantly influences its electrostatic interaction with the membrane. Near this pH, electrostatic repulsion between protein molecules and the membrane surface is minimized, leading to maximum protein aggregation, enhanced hydrophobic interactions, and severe surface adsorption fouling.

41. (B) Optimizing the cross-flow velocity
Optimizing cross-flow velocity is the primary operational strategy for controlling concentration polarization in industrial cross-flow microfiltration. High velocities generate high shear forces along the membrane surface, which destabilizes the polarized boundary layer and sweeps accumulated particles back into the retentate stream, reducing hydraulic resistance and stabilizing the permeate flux over time.

42. (B) High fouling at the inlet due to excessive pressure
In long ceramic or tubular modules, the high pressure drop from inlet to outlet can cause excessively high local transmembrane pressure at the inlet, leading to rapid, severe fouling. Applying Uniform Transmembrane Pressure principles by co-currently recirculating the permeate reduces this pressure differential at the inlet, ensuring uniform flux and fouling distribution.

43. (A) Back-pulsing involves brief, frequent reversals of permeate flow.
Back-pulsing is an online physical cleaning technique featuring extremely brief and frequent reversals of permeate flow through the membrane, typically lasting only a few seconds. This rapid reverse action dislodges deposited particles and disrupts the developing boundary layer without interrupting the filtration cycle, unlike traditional backwashing which requires longer, offline operational shutdowns.

44. (C) To increase the Reynolds number and enhance back-transport of solutes
Turbulence promoters, such as static mixers or mesh spacers, are inserted into membrane flow channels to disrupt laminar flow and increase the Reynolds number. By inducing localized eddies and fluid mixing, these inserts enhance the mass transfer coefficient, which promotes the back-transport of accumulated solutes away from the membrane surface and minimizes concentration polarization.

45. (B) III and IV
Turbulence promoters increase flow resistance, which significantly raises the pumping energy required. Additionally, back-pulsing cannot be used on spiral-wound polymeric modules, as reverse pressure pulses would cause structural delamination of the glued membrane envelope. Conversely, high cross-flow velocities and Uniform Transmembrane Pressure systems are highly effective and standard strategies for controlling membrane fouling.

46. (C) Warm water rinse to purge residual fluid
The first step in a standard Cleaning-in-Place protocol is rinsing the system with warm water.

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9. (B) It defines a threshold where 100 percent of all larger molecules are completely rejected.
Molecular weight cut-off is a nominal rating expressing the solute size at which a membrane achieves ninety percent rejection. It does not represent an absolute barrier that guarantees complete hundred percent rejection of all molecules above that size, because membrane pores exhibit a size distribution and polymer chains undergo dynamic structural fluctuations during filtration processes.

10. (B) Microfiltration
Microfiltration operates in the largest pore size range among pressure-driven membrane separation technologies, typically spanning from zero point one to ten micrometers. This open structure allows dissolved solutes, proteins, and minerals to pass freely into the permeate while successfully retaining suspended solids, large fat globules, somatic cells, and various bacterial species from the feed stream.

11. (A) High hydrophilicity and low fouling tendency
Cellulose acetate is a widely used polymeric membrane material characterized by its naturally high hydrophilicity and low susceptibility to organic fouling, particularly from proteins. However, this material has notable limitations, including a restricted operational pH range and susceptibility to thermal degradation, requiring mild processing conditions and careful enzymatic or chemical sanitization procedures during operation.

12. (C) Broad pH and temperature tolerance during cleaning
Polysulfone and polyethersulfone are highly robust synthetic polymers preferred in the dairy industry due to their excellent chemical and thermal stability. These membranes withstand wide pH ranges and elevated temperatures, allowing for aggressive daily cleaning-in-place cycles using hot alkaline and acidic sanitizing agents without compromising the structural integrity or separation performance of the polymeric membrane.

13. (D) Reverse Osmosis
Polyamide thin-film composite membranes are the industry standard for reverse osmosis processes because their dense active skin layers provide superior salt rejection and high water permeability. These cross-linked aromatic polyamide structures allow for efficient water passage while retaining small organic molecules and ionic mineral species, although they remain vulnerable to degradation by chlorine-containing oxidizing agents.

14. (C) Hydrophilicity
Hydrophilicity is the physical property describing a material's affinity for water, allowing a protective hydration layer to form spontaneously on the membrane surface. This water layer acts as a barrier that prevents hydrophobic interactions between the membrane and organic foulants like proteins, thereby reducing protein adsorption, minimizing flux decline, and improving overall cleaning efficiency.

15. (A) Both A and R are true and R is the correct explanation of A.
Ceramic membranes are ideal for highly fouling dairy streams because their inorganic nature provides exceptional mechanical, thermal, and chemical resistance. This robust construction permits aggressive cleaning protocols utilizing strong acids, concentrated alkalis, and extremely high temperatures to completely remove stubborn foulants, which would otherwise chemically degrade or structurally damage delicate polymeric membrane alternatives under similar operational conditions.

16. (D) Zirconia
Zirconia, or zirconium dioxide, is widely preferred for fabricating the thin active separation layers of inorganic ceramic membranes used in dairy processing. Zirconia offers outstanding chemical durability across the entire pH spectrum, exceptional thermal stability during high-temperature steam sterilization, and excellent wear resistance against abrasive particles, making it ideal for processing concentrated milk streams.

17. (A) High cost and structural brittleness
Despite their excellent separation performance and durability, inorganic ceramic membranes made of titania and alumina possess high manufacturing costs and physical brittleness. These materials require substantial initial capital investment compared to polymeric membranes and are highly susceptible to mechanical damage from physical impacts, rapid pressure spikes, or thermal shocks during routine plant operations.

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somatic cells, bacterial spores, and vegetative bacterial cells from skim milk. This reduction in microbial load, combined with pasteurization, significantly extends the product's shelf-life under refrigerated conditions without requiring high-heat treatments that degrade flavor and native proteins.

57. (B) Residual lipid complexes and phospholipids
In whey processing, microfiltration is used to clarify or defat cheese whey by removing residual lipids, colloidal fat, and phospholipid-rich fragments. Removing these lipid components prevents them from fouling subsequent ultrafiltration membranes and ensures high purity and excellent functional properties, such as gelling and foaming, in the final whey protein concentrate products.

58. (B) Preservation of flavor compounds and native proteins
Cold pasteurization using microfiltration physical separation avoids high-temperature heat treatments that cause thermal denaturation of heat-sensitive milk proteins and flavor compounds. This physical filtration preserves the fresh taste, native enzyme activity, and bioactive proteins of milk, delivering a high-quality product with an extended shelf-life under refrigerated storage conditions.

59. (C) 1.4 micrometers
A nominal pore size of one point four micrometers is standard for removing bacterial spores from skim milk using microfiltration. This pore size effectively retains large bacterial spores and somatic cells while allowing casein micelles, whey proteins, lactose, and minerals to pass into the permeate without causing premature membrane fouling or protein loss.

60. (C) Pre-concentration of milk or whey by water removal
Reverse osmosis is primarily used in the dairy industry to pre-concentrate milk or whey by removing water prior to evaporation and drying. This process retains all milk solids, including proteins, lactose, fat, and minerals, making it a highly energy-efficient alternative for volume reduction that lowers thermal energy consumption in subsequent processing steps.

61. (D) NF passes monovalent ions while rejecting polyvalent ions and organics.
Nanofiltration differs from reverse osmosis by having a slightly looser, charged membrane structure that allows monovalent ions like sodium and chloride to pass through, while rejecting polyvalent ions, lactose, and organic compounds. This selective permeability allows nanofiltration to achieve partial demineralization and concentration of dairy streams simultaneously, operating at lower pressures.

62. (C) Reverse Osmosis
Reverse osmosis is utilized to recover and purify evaporator condensate, often called cow water, within dairy processing facilities. Due to its tight membrane pore structure, reverse osmosis retains organic impurities, volatile compounds, and minerals, producing high-quality permeate water that can be safely recycled for cleaning-in-place operations and boiler feed water.

63. (B) Lactic acid and monovalent salts
Nanofiltration is highly effective for whey processing because it concentrates lactose and valuable proteins while selectively passing monovalent mineral salts and lactic acid into the permeate. This simultaneous concentration and partial demineralization reduces the salty taste of whey powder, improving its nutritional profile and quality for use in infant formula and confectionery products.

64. (D) Thermal energy required for subsequent evaporation is reduced.
Pre-concentrating whey via reverse osmosis removes a significant portion of water without using heat, which dramatically reduces the volume of liquid sent to the evaporator. This physical concentration lowers the thermal energy required for subsequent evaporative concentration and drying steps, leading to substantial utility cost savings and improved processing capacity in dairy plants.

65. (A) P-3, Q-1, R-4, S-2
Microfiltration is applied for spore removal in ESL milk. Ultrafiltration is used for milk protein standardization. Nanofiltration removes monovalent salts to achieve partial demineralization of whey, and reverse osmosis is standard for the pre-concentration of whey by removing only water, retaining all solids without salt removal.

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27. (A) To maintain uniform flux and optimize stage energy
Multi-stage membrane plants optimize large-scale operations by dividing the concentration process into separate stages, each operating at its own optimized pressure, concentration, and flux. This design prevents the entire system from operating under the lowest flux conditions of the final concentrate, which improves overall energy efficiency, reduces membrane area requirements, and maintains stable plant productivity.

28. (C) 5
The Volume Concentration Factor is calculated by dividing the initial feed volume by the final retentate volume. In this scenario, dividing one thousand liters of skim milk feed by the final retentate volume of two hundred liters yields a factor of five, indicating that the bulk solution has been concentrated five-fold relative to its original volume.

29. (D) 95 percent of the solute is retained by the membrane.
A retention coefficient of zero point nine five indicates that ninety-five percent of the target solute present in the feed is rejected and retained by the membrane, remaining in the retentate stream. Consequently, only five percent of that solute passes through the semi-permeable barrier into the permeate, demonstrating a highly efficient separation for that component.

30. (C) $M_f = M_r + M_p$
The principle of conservation of mass dictates that the total mass entering a membrane system must equal the total mass exiting the system. Therefore, the mass of the initial feed must equal the sum of the mass of the final concentrated retentate and the mass of the separated permeate generated during the filtration run.

31. (B) Retention coefficient is 0.0
A solute is considered freely permeable through a membrane when its retention coefficient is exactly zero. Under this condition, the membrane offers no barrier to the passage of the solute, resulting in equal concentration of that specific solute in both the permeate and retentate streams, which is typical for water and very small ions.

32. (D) Concentration polarization
Concentration polarization refers to the reversible accumulation of retained solutes in a thin boundary layer adjacent to the active membrane surface during pressure-driven filtrations. This localized concentration gradient increases the resistance to fluid flow, enhances solute passage, and can promote gel layer formation, directly reducing the overall efficiency of the membrane separation process.

33. (A) Mass transfer coefficient
The film theory model utilizes the mass transfer coefficient to quantify the back-diffusion of accumulated solute molecules from the membrane surface back into the bulk fluid stream. This parameter represents the rate of mass transport through the boundary layer, which is governed by feed channel geometry, fluid diffusion properties, and cross-flow velocity within the module.

34. (C) Permeate flux becomes independent of pressure.
Under the gel layer model, once the solute concentration at the membrane surface reaches its maximum thermodynamic limit, a cohesive gel layer forms. At this stage, any further increase in applied transmembrane pressure simply thickens this resistive gel layer, rendering the permeate flux completely independent of pressure and limiting the overall throughput of the system.

35. (A) II, IV, I, III
The development of concentration polarization begins with the application of transmembrane pressure, which drives fluid and solutes towards the membrane via convective transport. The membrane retains larger solutes, causing them to accumulate at the surface. Eventually, back-diffusion balances convective transport, establishing a stable, steady-state concentration boundary layer adjacent to the active membrane.

36. (D) Increasing cross-flow velocity
Increasing the cross-flow velocity is the most effective operational method to reduce the thickness of the concentration polarization boundary layer. High velocity increases fluid shear and turbulence along the membrane surface, which sweeps away accumulated solutes and enhances back-transport of retained components into the bulk stream, thereby maintaining high permeate flux during operation.

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76. (C) MPC contains casein and whey in the same ratio as skim milk.
Milk Protein Concentrate is produced by ultrafiltering skim milk, which retains both casein and whey proteins. This separation preserves the native protein ratio of approximately eighty percent casein and twenty percent whey found in raw milk, whereas Whey Protein Concentrate is derived solely from whey and contains no casein proteins.

77. (D) Ultrafiltration and diafiltration
Milk Protein Isolate is produced from skim milk using ultrafiltration and diafiltration. Ultrafiltration retains the casein micelles and whey proteins while removing lactose, water, and soluble minerals. Subsequent diafiltration washes out residual lactose and minerals, increasing the protein content to ninety percent or more on a dry basis.

78. (C) Microfiltration (0.1-0.2 micrometer)
Fractionation of micellar casein and whey proteins directly from skim milk is achieved using microfiltration with a pore size of zero point one to zero point two micrometers. This membrane retains large casein micelles, while allowing smaller, soluble whey proteins, lactose, and minerals to pass into the permeate, creating a purified micellar casein retentate.

79. (B) Native whey proteins
When skim milk is microfiltered using membranes with pore sizes of zero point one to zero point two micrometers, larger components like micellar casein are retained. The primary protein components passing through the membrane into the permeate are native whey proteins, along with soluble minerals, lactose, and water, yielding a serum protein-rich stream.

80. (D) MPC-85 contains significantly more lactose than MPC-50.
In Milk Protein Concentrates, higher protein grades, such as MPC-85, undergo more extensive ultrafiltration and diafiltration compared to lower grades like MPC-50. This additional filtration washes out more lactose and soluble minerals, meaning MPC-85 contains significantly less lactose than MPC-50, which contradicts the claim that MPC-85 contains more lactose.

81. (A) High water-binding capacity
Whey Protein Concentrate possesses a high water-binding capacity, making it valuable in processed meats and bakery products. It binds water and prevents moisture loss during cooking, which improves product yield, texture, and juiciness while enhancing crumb structure and shelf-life in baked goods by retarding staling over time.

82. (C) Thermal denaturation of proteins
The gelation of Whey Protein Isolate is triggered by thermal denaturation during processing. Heating destabilizes the globular proteins, exposing their hydrophobic cores and free sulfhydryl groups. These unfolded molecules then aggregate and form a three-dimensional network that traps water, creating a cohesive gel structure valued in food applications.

83. (A) Whey Protein Isolate
Whey Protein Isolate is highly valued for its foaming properties, which are ideal for aerated desserts. Due to its high protein concentration and low fat content, WPI rapidly adsorbs at the air-water interface during whipping, unfolding to form a stable, elastic cohesive film that traps air bubbles and prevents foam collapse.

NODIA

84. (D) Casein proteins
The emulsifying capacity of Milk Protein Concentrate is driven by casein proteins, which are highly surface-active. Caseins possess distinct hydrophobic and hydrophilic regions, allowing them to adsorb rapidly at oil-water interfaces during homogenization. This amphiphilic structure reduces interfacial tension and forms a protective film around fat droplets, preventing coalescence and stabilizing emulsions.

85. (A) I, II, IV, and V
Whey Protein Isolate exhibits high solubility, and its heat-induced gelation is irreversible. Fractionated native whey proteins also have superior functionality compared to cheese whey proteins due to the absence of glycomacropeptides. The water-binding capacity of Milk Protein Concentrate increases, rather than decreases, with higher protein content, making the third statement incorrect.

86. (B) Incomplete hydration leads to sedimentation.
Incomplete hydration of high-protein Milk Protein Isolates due to low solubility can cause

powder sedimentation, gritty mouthfeel, and phase separation in ready-to-drink nutritional beverages. To prevent these defects, dairy processors must optimize hydration times, temperatures, and mineral balances to ensure the proteins dissolve and remain stable during storage.

87. (D) To remove proteins prior to crystallization
In lactose manufacturing, ultrafiltration is used to remove proteins from whey or milk before crystallization. Eliminating these macromolecular proteins prevents them from interfering with lactose crystal growth and crystallization kinetics, which increases the crystallization yield and produces a high-purity lactose product free of protein contamination.

88. (A) Desalting and concentration
Processing ultrafiltration permeate using nanofiltration achieves the dual objectives of desalting and concentration. The nanofiltration membrane retains lactose and polyvalent ions while allowing monovalent salts like sodium and chloride to pass into the permeate, concentrating the carbohydrate stream and partially demineralizing it, which reduces the salt content of the final lactose.

89. (B) Addition of lactase
Low-lactose milk powders are produced by combining ultrafiltration with lactase treatment. Ultrafiltration physically removes a large portion of the lactose, water, and soluble minerals in the permeate. Lactase enzyme is then added to hydrolyze the remaining lactose in the retentate into glucose and galactose, achieving a low-lactose content without oversweetening the milk.

90. (B) Microfiltration for spore removal
While ultrafiltration, nanofiltration, and reverse osmosis are used to remove proteins, concentrate lactose, and reduce water volume during lactose recovery, microfiltration for spore removal is least relevant. Microfiltration is a clarification step for raw milk or whey, and does not directly impact the concentration, demineralization, or crystallization of lactose from the permeate stream.

91. (A) UF standardizes protein without adding non-dairy solids.
Ultrafiltration standardizes milk protein by physically removing lactose, minerals, and water in the permeate, which concentrates the native proteins without adding non-dairy ingredients or dry powders. This process maintains the natural milk matrix and casein-to-whey ratio, ensuring clean-label compliance, unlike traditional methods that rely on adding skim milk powder or condensed milk.

92. (C) Skim milk concentrated to the cheese solids content
Liquid pre-cheese refers to skim milk that has been concentrated via ultrafiltration to match the exact composition, fat, protein, and total solids content of the target cheese. This retentate can then be directly coagulated with rennet and starter cultures, streamlining the cheese-making process and significantly increasing production capacity.

93. (D) It generally decreases RCT due to closer micelle proximity.
Standardizing milk protein using ultrafiltration increases the concentration of casein micelles in the retentate, bringing them into closer proximity. This closer packing accelerates the aggregation phase of enzymatic coagulation, which decreases the rennet coagulation time and results in faster curd firming during the cheese-making process.

94. (C) Whey proteins
Cheese yield is significantly optimized through ultrafiltration because the membrane retains whey proteins, such as beta-lactoglobulin and alpha-lactalbumin, which are normally lost in the whey during traditional cheese making. When using concentrated retentate, these whey proteins become physically entrapped within the curd matrix, increasing the total cheese yield per unit of milk.

95. (D) A is false but R is true.
Using highly concentrated liquid pre-cheese is not ideal for hard cheeses like Cheddar because these varieties require extensive moisture removal and syneresis. Releasing moisture uniformly from a highly concentrated curd is difficult, making the assertion false, while the reason accurately describes the technical challenge of moisture control in hard cheese production.

96. (D) Decreased syneresis and a firmer gel structure
Yogurt manufactured from ultrafiltered milk shows significant rheological improvement, characterized by a firmer gel structure and

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decreased syneresis. The increased protein concentration strengthens the acid-induced gel network, enhancing water retention within the protein matrix and preventing whey separation, which improves product texture and stability during storage.

97. (A) Hanging the curd to drain whey
Using ultrafiltration for the continuous mechanized production of chakka replaces the traditional, unhygienic step of hanging yogurt curd in cloth bags to drain the whey. Ultrafiltration continuously separates whey from the curd under pressure, which improves yield, ensures consistent total solids, and maintains a closed, hygienic processing system.

98. (C) Managing high retentate viscosity
When processing skim or whole milk into a paneer base using ultrafiltration, managing high retentate viscosity is a key challenge. High protein concentration increases viscosity, which can cause flow distribution issues, high pressure drops, and localized fouling in the heat exchangers and membrane modules, requiring optimized operating temperatures and flow rates.

99. (A) Fluid milk
Fluid milk is least likely to benefit from the direct incorporation of reverse osmosis-concentrated milk due to potential mineral imbalances and salty off-flavors from the retained mineral salts. In contrast, products like ice cream mix, yogurt, and sweet shrikhand can easily mask these subtle mineral flavors with added sugars, fats, and flavorings.

100. (D) Fluid hydrodynamics and channel dimensions
In the film theory model, the boundary layer mass transfer coefficient is determined by fluid hydrodynamics and channel dimensions. Factors such as feed flow velocity, temperature-dependent viscosity, and spacer geometry govern the Reynolds and Schmidt numbers, which dictate solute transport away from the membrane surface and back into the bulk stream.

101. (B) Residence time causes stress on the fluid.
The main disadvantage of batch membrane processing in large industrial installations is the long residence time of the fluid in the system. Recirculating the feed for several hours subjects shear-sensitive proteins and fats to continuous mechanical stress and thermal load, which can cause protein denaturation, fat globule damage, and microbial growth.

102. (C) Ease of removal via physical or chemical cleaning
Fouling is classified as reversible or irreversible based on how easily it can be removed from the membrane. Reversible fouling consists of loose deposits that are easily removed by physical washing, while irreversible fouling involves strongly adsorbed or precipitated foulants within the pores that require targeted chemical cleaning-in-place cycles to remove.

103. (D) The flux will remain unchanged.
In the mass transfer-controlled regime of ultrafiltration, the rate of filtration is limited by solute transport away from the membrane. Increasing the transmembrane pressure does not increase flux; instead, it thickens the polarized boundary or gel layer, increasing hydraulic resistance and leaving the steady-state permeate flux completely unchanged.

104. (A) Net driving pressure
Net driving pressure is defined as the applied hydrostatic transmembrane pressure minus the difference in osmotic pressure across the membrane. This parameter represents the actual physical driving force available to push water and permeable solutes through the semi-permeable barrier, and is critical for sizing reverse osmosis and nanofiltration systems.

105. (A) P-2, Q-4, R-3, S-1
Tubular modules offer low packing densities due to their wide channels, while plate-and-frame modules have moderate packing densities. Spiral-wound modules provide high packing densities, and hollow fiber configurations deliver very high packing densities by packing thousands of fine fibers into a single vessel, maximizing filtration surface area per unit volume of the module.

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106. (B) PES contains more sulfone groups, granting hydrophilicity.
Polyethersulfone differs chemically from polysulfone by having a higher density of sulfone groups and ether linkages, and lacking aliphatic isopropylidene groups in its polymer backbone. This chemical structure increases its hydrophilicity, which reduces the adsorption of proteins and organic molecules and improves the fouling resistance of the membrane.

and increasing concentration, until the target concentration factor is achieved.

161. (D) The gel forms faster and achieves a firmer curd tension in less time.
Using ultrafiltered retentate to standardize cheese milk concentrates casein micelles and calcium. This higher protein density accelerates the enzymatic action of rennet, causing the coagulation gel to form faster. The increased concentration of structural proteins promotes rapid curd firming, resulting in a significantly firmer curd tension and stronger gel network in less processing time.

162. (C) Flux is modeled as the mass transfer coefficient multiplied by the log ratio of wall to bulk concentration.
In membrane filtration modeling, film theory describes transport dynamics when concentration polarization occurs. Under steady-state conditions, convective transport of solutes toward the membrane balances back-diffusion into the bulk stream. The resulting permeate flux is mathematically modeled as the mass transfer coefficient multiplied by the natural logarithm of the ratio of solute concentration at the membrane wall to bulk concentration.

163. (B) Processed cheese spreads and coffee creamers.
Milk Protein Concentrates exhibit excellent emulsifying properties due to their amphiphilic protein structures, which stabilize fat-water interfaces. This functionality is highly valuable in processed cheese spreads and coffee creamers, where proteins act as emulsifiers to prevent fat separation. Utilizing these concentrates ensures a stable, homogeneous emulsion, enhancing the smooth texture and creaminess of these products.

164. (D) Initiating an aggressive chemical CIP cycle precisely tailored to the specific organic foulant.
Irreversible organic fouling cannot be resolved by physical flushing or pressure changes because proteins and lipids are chemically bound to the polymeric membrane surface. The most effective strategy is to execute a targeted chemical CIP cycle. This protocol employs alkaline agents, surfactants, and enzymes to break down organic structures, chemically solubilizing and removing the foulants.

165. (A) Both A and R are true and R is the correct explanation of A.
Maintaining high cross-flow velocity is essential when operating tubular membrane modules with concentrated dairy streams. High fluid velocity generates high shear forces along the membrane wall, which continuously sweep away accumulated proteins and suspended solids. This active shear cleaning mitigates concentration polarization, limits the thickness of the gel layer, and maintains high permeate flux.

166. (C) Transmission coefficient
The transmission coefficient is a mathematical metric that describes the proportion of a specific solute that passes through the membrane barrier. It is defined as the concentration of the solute in the permeate divided by its concentration in the retentate or feed. This coefficient is the mathematical complement of the retention coefficient during membrane separation processes.

167. (A) They possess a highly restricted operational pH and temperature range, making standard CIP protocols difficult.
Cellulose acetate membranes are severely limited by their narrow chemical and thermal stability, restricted to pH ranges between four and eight and temperatures below thirty-five degrees Celsius. Standard dairy CIP protocols require highly alkaline conditions and elevated temperatures to clean fat and protein foulants. Operating cellulose acetate under these harsh conditions causes rapid, irreversible hydrolysis and polymer degradation.

168. (D) Lactose
Nanofiltration membranes feature a typical molecular weight cut-off between one hundred and five hundred daltons. Lactose is a disaccharide with a molecular weight of approximately three hundred and forty-two daltons, placing it above the membrane's filtration threshold. Consequently, lactose is completely rejected by the membrane, while water and small monovalent mineral ions pass into the permeate.

169. (B) It unfolds upon heating, exposing free sulfhydryl groups that form cross-links and a robust gel network.
Beta-lactoglobulin is the primary globular protein in whey and plays a central role in thermal gelation. Heating above sixty-five

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117. (A) Feed spacers are easily blocked by particulates or highly viscous retentate.
Spiral-wound modules utilize narrow feed channels containing mesh-like spacers to promote turbulence. When processing highly viscous fluid streams, such as concentrated dairy products, these narrow spacer grids easily capture suspended particulates and cause severe localized flow restrictions. This physical blockage rapidly increases pressure drops and leads to catastrophic clogging within the spacer channels.

118. (C) Parallel pressure vessels decrease in successive stages to maintain optimal cross-flow velocity.
As feed water travels through multi-stage reverse osmosis systems, the total volume of retentate decreases as permeate is removed. To compensate for this fluid loss and maintain the high cross-flow velocity required to prevent concentration polarization, successive stages employ fewer parallel pressure vessels. This tapered physical arrangement resembles a traditional Christmas tree configuration.

119. (C) 1.2 to 1.4 micrometers
Isolating somatic cells and bacteria from skim milk requires a membrane with a precise pore size that prevents these large microbiological entities from passing. Somatic cells and bacteria are typically larger than one micrometer, whereas native casein micelles are smaller. Operating within a range of 1.2 to 1.4 micrometers ensures complete bacterial retention with minimal casein loss.

120. (D) Ester bonds
Cellulose acetate is a polymeric membrane material containing abundant ester bonds. These functional groups are chemically unstable when exposed to extreme pH environments. Under highly acidic or alkaline conditions, the ester linkages undergo rapid chemical hydrolysis, converting back into hydroxyl groups. This molecular degradation destroys the membrane's structural integrity, causing irreversible loss of salt rejection properties.

121. (B) Passage of monovalent ions
Nanofiltration membranes exhibit selective permeability, rejecting multivalent salts while allowing the partial passage of monovalent ions such as sodium and chloride. Modeling a nanofiltration system for salty whey requires a detailed mass balance that accounts for this ion transport behavior. Standard ultrafiltration calculations do not require this variable because ultrafiltration membranes are fully permeable to all salts.

122. (C) Microfiltration to remove residual lipids followed by standard ultrafiltration.
Whey protein ingredients used in clear acidic beverages must have exceptionally low fat contents to prevent turbidity and sediment. Microfiltration acts as a pre-treatment step to remove residual lipids and fat globule membrane fragments from liquid whey. Subsequent ultrafiltration concentrates the defatted proteins, yielding a highly soluble, lipid-free whey protein isolate that remains transparent in acidic solutions.

123. (D) UF retentate coagulates much slower than unconcentrated milk, requiring more rennet.
Concentrated ultrafiltration retentate actually coagulates much faster than unconcentrated milk when exposed to rennet, owing to the high concentration of casein micelles. This accelerated enzymatic reaction significantly reduces coagulation time and curd-cutting times. Consequently, less rennet is required per unit of milk protein in concentrated retentates to achieve optimal curd firmness compared to traditional cheese-making processes.

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124. (A) Lactose hydrolysis by active enzymes (such as lactase) retained by the membrane while allowing hydrolyzed monosaccharides to pass in the permeate.
An enzymatic membrane reactor integrates chemical conversion and physical separation. Lactase enzymes are mixed into the ultrafiltration feed to hydrolyze lactose into glucose and galactose. The membrane's molecular weight cut-off is designed to retain the large enzyme molecules while allowing the smaller, hydrolyzed monosaccharides to pass freely into the permeate stream, achieving continuous hydrolysis and recovery.

125. (A) Both A and R are true and R is the correct explanation of A.
Microfiltration is highly effective for separating casein micelles from whey proteins in skim milk because of their distinct physical sizes. Casein micelles exist as large colloidal particles spanning 0.05 to 0.3 micrometers, whereas native whey proteins are individual globular proteins under

by low-molecular-weight species like lactose and monovalent minerals. Suspended proteins and fats contribute negligibly to osmotic pressure due to their exceptionally high molecular weights.

179. (B) A physical breach or rupture in the membrane surface or seals.
A sudden, severe drop in solute rejection combined with an unexpected increase in permeate flux indicates a mechanical failure within the membrane module. This behavior is typically caused by a physical breach or rupture in the membrane polymer or a failure of the internal O-ring seals, which allows unfiltered bulk feed to bypass the selective barrier completely.

180. (D) Ultrafiltration followed by extensive diafiltration.
Producing Whey Protein Isolate with negligible lactose content requires separating whey proteins from low molecular weight sugars. Standard ultrafiltration concentrates the proteins but retains dissolved lactose. Following ultrafiltration with extensive diafiltration, where fresh water is added to wash out permeable species, successfully reduces lactose to negligible levels, yielding a highly purified protein isolate.

181. (A) Fermenting the skim milk with a lactic acid starter culture before or after ultrafiltration.
The characteristic sour flavor of chakka is achieved biochemically through fermentation. Skim milk is inoculated with a lactic acid starter culture, which ferments lactose into lactic acid. This fermentation step can be performed either on the raw skim milk before ultrafiltration or directly on the concentrated retentate, achieving the required flavor profile and acidity.

182. (C) It offsets fresh water intake by providing high-quality reusable water for CIP or boiler feed.
In dairy facilities, evaporator condensate, often called cow water, contains volatile organic compounds but minimal minerals. Processing this water through reverse osmosis removes trace impurities, producing highly purified water. Reusing this water for clean-in-place cycles or boiler feed significantly offsets fresh water intake, providing substantial economic savings and environmental benefits.

183. (A) Micellar casein
Processing skim milk with a 0.1 micrometer microfiltration membrane targets the separation of casein micelles from soluble proteins. Casein micelles exist in the size range of 0.05 to 0.3 micrometers, meaning they are predominantly retained by the membrane. Soluble whey proteins, which are much smaller, pass freely into the permeate, concentrating micellar casein in the retentate.

184. (D) It exhibits inverse solubility, meaning it tends to precipitate onto the membrane surface at higher processing temperatures.
Calcium phosphate management is challenging in dairy processing because of its inverse solubility. Unlike most salts, its solubility decreases as the temperature rises. Operating membrane plants at elevated temperatures causes calcium phosphate to precipitate out of solution, forming hard mineral scale on the membrane surface that restricts flow and requires acidic cleaning cycles to remove.

185. (B) II and V
Diafiltration is a highly effective method for washing out permeable low molecular weight species, such as dissolved minerals and lactose, from the retentate. Conversely, it is completely ineffective at removing large macromolecules like casein, which are retained by the membrane. Thus, statements claiming diafiltration removes casein or fails to remove dissolved minerals are incorrect.

186. (C) Ultrafiltration
Ultrafiltration is a pressure-driven membrane process that operates within a moderate pressure range, typically between one and ten bar. This process utilizes asymmetric polymeric membranes to selectively separate macromolecules, such as proteins, from solvent and small dissolved solutes. The hydrostatic pressure serves as the driving force to push water and permeable microsolutes through the membrane.

187. (D) A highly concentrated boundary layer of retained macromolecules that exhibits solid-like flow resistance.
During ultrafiltration, retained macromolecules accumulate at the membrane surface, forming a dense boundary layer. As concentration increases, the macromolecules become closely packed, transitioning into a cohesive, highly

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134. (C) Establishment of the concentration polarization layer and initial protein adsorption.
Upon initiating ultrafiltration, dissolved proteins are rapidly transported toward the membrane surface by convective flow. These macromolecules accumulate in the boundary layer, establishing concentration polarization within minutes. Simultaneously, proteins adsorb onto the membrane polymer. Both phenomena introduce new physical resistances to water transport, causing a rapid, characteristic drop in permeate flux from its initial clean-water value.

135. (A) P-3, Q-2, R-1, S-4
Sodium hydroxide saponifies fats and swells proteins, making them highly soluble. Nitric acid dissolves stubborn calcium phosphate and other inorganic scale. Protease enzymes hydrolyze protein peptide bonds under mild conditions. Hydrogen peroxide serves as a strong oxidizer for thorough sanitization. These specialized cleaning agents target distinct foulant components, enabling complete restoration of membrane performance.

136. (D) Polyamide
Polyamide thin-film composite membranes contain amide linkages that are highly sensitive to strong oxidizing agents. Exposure to trace levels of free chlorine in wash water initiates a chemical reaction that cleaves these amide bonds. This irreversible degradation disrupts the polymer matrix, resulting in permanent structural damage, loss of selectivity, and a sudden increase in salt passage.

137. (B) 25-30 percent
Concentrating skim milk via reverse osmosis is limited to 25 to 30 percent total solids. Beyond this threshold, the concentration of dissolved minerals and lactose increases exponentially, generating extreme osmotic pressures. High solid levels also cause a dramatic increase in milk viscosity, which restricts flow, increases pumping energy requirements, and reduces permeate flux to unsustainable levels.

138. (C) It functions through a solution-diffusion mechanism rather than convective flow through distinct pores.
An ideal reverse osmosis membrane lacks visible, physical pores. Instead, transport occurs through a solution-diffusion mechanism where water molecules dissolve into the non-porous polymeric active layer and diffuse down a chemical potential gradient. Solutes are rejected based on differences in solubility and diffusivity within the polymer matrix, preventing convective flow of bulk liquid.

139. (D) Membrane resistance, fouling resistance, and concentration polarization resistance.
The resistance-in-series model calculates the total resistance to permeate flux by summing distinct physical resistances. These components include the clean membrane resistance, the fouling resistance caused by irreversible protein adsorption and pore blocking, and the resistance from concentration polarization, which is the temporary accumulation of highly concentrated solutes adjacent to the membrane surface.

140. (A) The open channel design of plate-and-frame modules accommodates higher viscosities and particulate loads without catastrophic plugging.
Plate-and-frame modules utilize wide, open channels that do not rely on mesh-like spacers. This design allows highly viscous fluids and suspended particulates to flow through the system without causing physical blockages. In contrast, spiral-wound modules contain narrow feed spacers that act as filters, rapidly capturing debris and plugging when processing heavily fouling dairy streams.

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141. (B) The gel layer reaches its maximum concentration, causing its specific resistance to increase proportionally with pressure.
Increasing transmembrane pressure in ultrafiltration initially raises the permeate flux. However, this increased flow carries more macromolecules to the membrane surface, thickening the gel layer. Eventually, the gel layer reaches its maximum concentration, where any subsequent pressure increase compresses the gel, raising its specific transport resistance proportionally and resulting in a constant, pressure-independent flux plateau.

142. (B) Rejection is strongly influenced by molecular shape, structural flexibility, and specific membrane surface interactions.
Molecular Weight Cut-Off is an estimate because solute rejection is not determined by molecular mass alone. The three-dimensional shape, structural flexibility, and electrical charge of a molecule strongly influence its permeation. Linear, flexible molecules can uncoil and pass through pores, while electrostatic interactions

between the solute and the membrane surface can alter rejection performance.

143. (A) Ceramic tubular
Ceramic tubular membranes feature exceptional mechanical strength and chemical resistance, allowing them to withstand rapid, high-pressure reversals of flow. This physical robustness enables the operation of back-pulsing, where clean permeate is forced backward through the membrane pores. This mechanical action dislodges accumulated surface foulants and gel layers, effectively maintaining high permeate flux during processing.

144. (C) It creates a smoother, more uniform texture and richer mouthfeel due to retained whey proteins.
Incorporating ultrafiltered retentate into the manufacture of traditional shrikhand retains whey proteins that are normally lost during whey drainage. These retained hydrophilic proteins bind water effectively, creating a smoother and more uniform texture. They also improve the overall yield and impart a richer, creamier mouthfeel to the final acidified dairy dessert.

145. (A) I, III, IV, II
Membrane separation processes operate at different hydraulic pressures based on pore size and osmotic pressure. Microfiltration uses the lowest pressure, typically under two bar, followed by ultrafiltration which runs at one to ten bar. Nanofiltration requires higher pressures to overcome moderate osmotic forces, while reverse osmosis demands the highest pressure to overcome the full osmotic pressure of small ions.

146. (C) The precise implementation of diafiltration to wash out residual lactose and minerals.
Achieving an eighty percent protein concentration in Whey Protein Concentrate requires removing non-protein solutes like lactose and minerals. Standard ultrafiltration concentrates proteins but leaves dissolved sugars and salts in the retentate water. Implementing diafiltration washes out these low molecular weight species, systematically increasing the protein-to-total-solids ratio in the final dried powder.

147. (B) Their relatively large molecular size compared to lactose and water molecules.
Ultrafiltration relies on size-exclusion to separate milk components. Whey proteins like beta-lactoglobulin and alpha-lactalbumin are large macromolecules with molecular weights exceeding fourteen kilodaltons. Water and lactose molecules are significantly smaller, typically under four hundred daltons. Choosing a membrane with an appropriate molecular weight cut-off retains the large whey proteins while allowing smaller molecules to pass.

148. (D) It significantly reduces the Biological Oxygen Demand of the discharged water by retaining organics.
Dairy processing effluents contain dissolved milk solids, lactose, and proteins that contribute to high Biological Oxygen Demand. Discharging these untreated organics degrades local aquatic ecosystems. Reverse osmosis acts as a concentration barrier, retaining almost all organic compounds and minerals. This clean-up generates highly purified permeate water, drastically reducing the pollution potential and environmental impact.

149. (A) Within the boundary layer immediately adjacent to the membrane surface.
During membrane filtration, convective flow carries solute molecules toward the active barrier. Since the membrane rejects these solutes, they accumulate at the surface faster than they can diffuse back into the bulk stream. This mass-transfer phenomenon creates a highly concentrated boundary layer located immediately adjacent to the membrane surface, known as concentration polarization.

150. (C) Measuring the pH and conductivity of the final rinse water.
Verifying the complete removal of acid or alkaline cleaning chemicals after a clean-in-place cycle requires assessing the rinse water properties. Acidic and alkaline cleaners alter the hydrogen ion concentration and introduce conductive mineral salts. Measuring pH and electrical conductivity of the final flush water ensures they match the incoming fresh water values, indicating zero chemical residue.

151. (A) High inlet pressures force casein micelles into membrane pores, causing irreversible internal fouling.
In microfiltration systems fractionating milk proteins, maintaining a uniform transmembrane pressure is critical. Without this control, high hydraulic pressures at the module inlet force

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casein micelles deep into the membrane pores. This results in severe internal pore blocking and irreversible fouling, which limits the transmission of whey proteins and reduces overall processing capacity.

152. (D) Cellulose acetate membranes are robust against biological degradation by cellulase enzymes.
Cellulose acetate membranes consist of a natural polymer backbone modified by acetylation. This organic structure remains highly susceptible to biological attack by cellulase enzymes produced by contaminating microorganisms. Cellulases enzymatically hydrolyze the cellulose backbone, causing rapid structural degradation, pinhole formation, and complete loss of the membrane's selective separation properties during processing.

153. (B) MPC coagulates with rennet because it contains native micellar casein, whereas WPC does not.
Milk Protein Concentrate contains native micellar casein, which is the specific substrate required for rennet-induced coagulation. Adding rennet cleaves kappa-casein, destabilizing the micelles and forming a firm gel. Whey Protein Concentrate contains primarily whey proteins like beta-lactoglobulin and alpha-lactalbumin. Lacking casein micelles, whey proteins do not undergo enzymatic coagulation when exposed to rennet.

154. (C) The pH where the protein has a net charge of zero, typically resulting in minimum solubility.
The isoelectric point is the specific pH at which a protein's net electrical charge becomes zero. At this point, electrostatic repulsion between protein molecules is minimized, causing them to aggregate and exhibit minimum solubility. This state significantly increases the risk of severe membrane fouling, as uncharged proteins readily deposit and form dense gel layers.

155. (B) I, III, and IV
Reverse osmosis permeate consists of highly purified water suitable for boiler make-up. Concentrating whey via reverse osmosis exponentially increases osmotic pressure, limiting concentration limits. Nanofiltration is highly effective for demineralizing salty whey because it partially lets monovalent salts pass while fully retaining lactose and proteins, thereby reducing the total ash content of the retentate.

156. (A) Feed flow rate divided by retentate flow rate
In continuous steady-state membrane plants, the Volume Concentration Factor measures the volume reduction achieved by the system. It is calculated by dividing the incoming volumetric feed flow rate by the exiting retentate flow rate. This ratio quantifies the concentration process, representing how many times the fluid volume has been reduced during the filtration run.

157. (B) Feed pH and temperature
Calcium bridging occurs when free calcium ions form electrostatic cross-links between proteins and the membrane surface, leading to severe fouling. The concentration of reactive calcium ions is dictated by feed pH and temperature, which govern calcium phosphate solubility. Monitoring and adjusting these variables prevents the precipitation of reactive mineral phases that initiate protein cross-linking.

158. (B) Fat globules and bacteria are similar in size, causing concurrent retention and rapid clogging.
Cold pasteurization via microfiltration is performed on skim milk because fat globules and bacterial cells share similar physical sizes, ranging from 0.5 to 10 micrometers. Processing whole milk causes the fat globules to be retained along with the bacteria, leading to massive fat losses and instantaneous clogging of the membrane pores.

159. (A) Ultrafiltration → Diafiltration → Enzymatic hydrolysis → Spray drying
Manufacturing low-lactose milk powder begins with ultrafiltration to concentrate the proteins while removing a portion of lactose in the permeate. Diafiltration follows, washing out residual sugars to achieve very low lactose levels. Enzymatic hydrolysis is then applied to split remaining lactose into glucose and galactose. Finally, the hydrolyzed retentate undergoes spray drying.

160. (C) A fixed feed volume is recirculated, removing only permeate until the target concentration is reached.
In a batch membrane concentration process, a fixed initial volume of feed liquid is loaded into a balance tank. This fluid is continuously recirculated through the membrane module, returning the concentrated retentate to the tank while removing permeate. This operation continues, steadily decreasing the tank volume

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0.01 micrometers. This physical size disparity allows selective passage of whey proteins while retaining casein.

126. (B) Protease
During ultrafiltration of whey, the membrane surface accumulates a dense foulant layer consisting predominantly of proteins like beta-lactoglobulin and alpha-lactalbumin. Removing this organic protein layer requires a protease enzyme, which selectively hydrolyzes the peptide bonds in the adsorbed proteins. This breakdown reduces them to soluble peptides, which are easily washed away during the cleaning cycle.

127. (A) Pumping permeate concurrently with retentate flow to maintain a constant pressure differential.
Uniform Transmembrane Pressure systems work by recirculating the permeate stream concurrently with the retentate stream. This concurrent pumping matches the pressure drop along the permeate side with the hydraulic pressure drop along the retentate side. Consequently, a uniform transmembrane pressure is maintained across the entire membrane length, preventing localized over-pressing and subsequent rapid fouling at the inlet.

128. (C) MPI preserves proteins in their native, soluble state, whereas co-precipitates undergo irreversible structural denaturation.
Milk Protein Isolate is produced using gentle membrane filtration techniques, such as ultrafiltration and diafiltration, which physically concentrate proteins without chemical or thermal denaturation. This process preserves the proteins in their native, fully soluble state. Conversely, traditional milk protein co-precipitates are produced via heat treatment and acid precipitation, resulting in irreversible structural denaturation and reduced solubility.

129. (D) It leads to off-flavors from lipid oxidation and impairs foaming and gelation properties.
Residual lipids in Whey Protein Concentrate are highly susceptible to chemical oxidation, generating undesirable volatile compounds and off-flavors during storage. Furthermore, these hydrophobic fat molecules physically compete with whey proteins at air-water interfaces, significantly impairing foaming capacity. They also interfere with the formation of a cohesive protein network during thermal gelation, resulting in weaker gels.

130. (C) Viscosity enhancement and moisture retention in meat products.
The water-binding capacity of a milk protein ingredient determines its ability to absorb and retain free water within a food matrix. In meat processing, adding these high-water-binding proteins enhances viscosity and prevents moisture loss during cooking. This improves cook yield, sensory juiciness, and structural cohesion of restructured or emulsified meat products.

131. (B) $C = C_0 \exp\left(-\frac{V_d}{V_r}\right)$
During constant-volume diafiltration, water is added to the retentate at the same rate that permeate is removed. The concentration of a fully permeable solute at any point is mathematically modeled by an exponential decay function. This relationship is expressed as the initial concentration multiplied by the exponential base raised to the negative ratio of diafiltration water volume to retentate volume.

132. (D) To maintain high cross-flow velocity across the membrane without requiring a massive feed pump.
In feed-and-bleed systems, the primary feed pump only supplies fresh feed equivalent to the bleed and permeate rates. The system incorporates a dedicated recirculation loop pump to continuously circulate fluid across the membrane. This decoupled design maintains the high cross-flow velocity required to control concentration polarization without needing an excessively large, energy-intensive primary feed pump.

133. (A) The required volumetric capacity and desired final concentration.
Selecting between continuous single-pass and multi-stage systems depends on volumetric throughput and target concentration. Single-pass configurations are appropriate for small volumes or modest concentration increases. Large industrial operations with high volumetric capacities and high final concentrations require multi-stage, feed-and-bleed designs, which optimize residence times, membrane area utilization, and pumping energy across successive concentration steps.

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degrees Celsius denatures the protein, causing its tertiary structure to unfold. This conformational change exposes highly reactive free sulfhydryl groups, which participate in disulfide-sulfhydryl exchange reactions, forming covalent cross-links that construct a robust gel network.

170. (C) Their absolute chemical inertness across the entire pH spectrum.
Processing high-acid whey streams requires membrane systems that can tolerate low operational pH values and harsh chemical cleaning conditions. Ceramic membranes are constructed from inorganic materials like alumina or zirconia, which exhibit absolute chemical inertness across the entire pH spectrum. This extreme chemical robustness prevents polymer degradation, extending operational lifespan compared to polymeric alternatives.

171. (D) To induce localized vortex shedding, thereby increasing mass transfer away from the surface.
Turbulence promoters are physical inserts, such as spacers or helical static mixers, integrated into membrane channels. Their main hydrodynamic function is to disrupt laminar flow patterns, inducing localized vortex shedding and fluid mixing. This turbulence increases the rate of mass transfer of rejected solutes back into the bulk stream, successfully mitigating concentration polarization.

172. (A) Coagulation via the addition of a heated acidulant like citric or lactic acid.
In continuous mechanized paneer production using ultrafiltration, the skim milk is concentrated to a specific solids level. To form the final paneer curd, this ultrafiltered retentate requires the addition of a heated food-grade acidulant like citric or lactic acid. This acid treatment drops the pH, initiating rapid, thermal-acid coagulation of the concentrated milk proteins.

173. (B) Applying a hydraulic pressure that exceeds the inherent osmotic pressure of the milk.
Applying a high hydraulic pressure to the feed stream allows reverse osmosis to separate pure water from milk solids. This applied pressure must exceed the milk's inherent osmotic pressure, which is exerted by dissolved sugars and mineral salts. Overcoming this thermodynamic barrier forces water molecules through the semi-permeable polymeric membrane while retaining all other milk components.

174. (B) Molecular Weight Cut-Off (MWCO)
Molecular Weight Cut-Off is an intrinsic physical property of the membrane, determined during manufacturing by controlling the polymer density and casting conditions. It defines the nominal solute mass that is ninety percent rejected by the membrane. Unlike transmembrane pressure, feed temperature, or cross-flow velocity, the nominal cut-off cannot be adjusted by the operator during processing.

175. (A) P-2, Q-1, R-4, S-3
Spiral-wound modules offer the lowest capital cost per square meter. Ceramic tubular systems require uniform transmembrane pressure to prevent inlet fouling. Open-channel plate-and-frame systems offer the highest physical resistance to particulate plugging. Hollow fiber modules place the active skin layer on the outside of capillaries. These features dictate module selection for specific dairy processing applications.

176. (C) Loop retentate concentration remains constant and equal to the final desired product concentration.
A feed-and-bleed configuration operates at steady state when the volume of fresh feed entering matches the sum of permeate and bleed streams exiting the system. Under these continuous conditions, the fluid properties inside the recirculation loop remain completely constant, meaning the loop retentate concentration matches the target concentration of the final product being bled off.

177. (D) Sodium hydroxide - Adsorbed beta-lactoglobulin
In dairy membrane operations, sodium hydroxide is highly effective for removing protein foulants like adsorbed beta-lactoglobulin. This strong alkaline cleaning agent increases the pH, which charges the protein molecules and promotes their electrostatic repulsion. It also swells the protein matrix and hydrolyzes proteins into smaller, highly soluble fragments, facilitating their complete removal.

178. (C) The total molar concentration of all dissolved solute particles.
According to the van 't Hoff equation, the osmotic pressure of a dairy fluid is directly proportional to the total molar concentration of all dissolved solute particles. In milk, this is primarily dictated

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107. (A) The membrane is functioning as a nanofiltration module.
A membrane that has low rejection for sodium chloride but high rejection for lactose is characteristic of nanofiltration. These charged, semi-permeable membranes allow small, monovalent ions like sodium and chloride to pass through while rejecting larger, uncharged organic molecules like lactose, making them ideal for partial demineralization.

108. (C) It forms an irreversible scale, restricting flux.
Controlling calcium phosphate precipitation is critical during milk processing because it forms a hard mineral scale on membrane surfaces and inside pores. This scaling acts as a barrier that increases hydraulic resistance, reduces permeate flux, and requires frequent, aggressive acid cleaning-in-place cycles, which can shorten the operational lifespan of polymeric membranes.

109. (D) Accumulation of foulants leading to blocking
The gradual decline in permeate flux during an extended run is caused by membrane fouling, where proteins, lipids, and minerals accumulate on the surface and within the pores. Over time, these foulants block pores and form a resistive gel layer, increasing the overall hydraulic resistance and restricting fluid passage through the membrane.

110. (C) Utilizing cooling mechanisms to maintain low temperatures
To prevent protein denaturation during prolonged batch ultrafiltration of whey, cooling mechanisms must be used to keep operating temperatures low, typically between ten and fifteen degrees Celsius. This temperature control protects heat-sensitive whey proteins, such as beta-lactoglobulin, from unfolding and aggregating, which preserves their native functional properties and minimizes membrane fouling.

111. (B) Solute removal follows a logarithmic decay.
Solute removal during diafiltration follows logarithmic decay kinetics as wash water is added to the system. Each added volume of wash water dilutes the permeable impurities in the retentate, causing their concentration to decrease exponentially over time, which allows for highly predictable and controllable purification of the retained macromolecular components.

112. (D) Maintenance of the natural protein ratio
Using ultrafiltration to adjust milk protein levels ensures compliance with regulations by maintaining the natural ratio of casein to whey proteins in the milk. Since ultrafiltration only removes water, lactose, and soluble minerals, the standardized milk retains its original protein composition and quality, avoiding the use of non-dairy additives or protein powders.

113. (A) Forward osmosis occurs, drawing water to the feed.
If the applied transmembrane pressure is less than the osmotic pressure of the feed solution, forward osmosis occurs. Under these conditions, the net driving force reverses, drawing water from the permeate side back across the semi-permeable membrane into the concentrated feed stream to dilute it, reversing the direction of normal filtration.

114. (C) Restoration of pure water flux
The restoration of pure water flux is the standard metric used to evaluate cleaning efficiency. By measuring the water flux under standardized conditions before and after a cleaning-in-place cycle, operators can quantify how effectively the chemical cleaners removed the foulants and restored the membrane's clean permeability to its original baseline value.

115. (B) I and III
Alumina ceramic membranes are highly resistant to abrasive particles, and ceramic structures can withstand steam sterilization at one hundred and twenty-one degrees Celsius. Conversely, zirconia is highly chemical-resistant and does not dissolve in alkaline cleaners; it is widely used for separation layers, which means that the second statement is incorrect.

116. (D) Hollow fibers are self-supporting capillaries with much smaller diameters, leading to higher packing density.
Hollow fiber membranes consist of narrow, self-supporting polymeric capillaries. Their miniature physical scale allows thousands of fibers to be bundled tightly into a single compact housing. This configuration achieves an exceptionally high membrane surface area per unit volume compared to large-diameter tubular systems, which require rigid mechanical support structures and offer significantly lower packing density.

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concentrated gel layer. This layer exhibits solid-like properties and introduces massive hydraulic resistance to permeate transport, which restricts flux regardless of subsequent pressure increases.

188. (A) Designs requiring high cross-flow velocities, like tubular modules, demand significantly higher pumping energy.
The physical configuration of membrane modules dictates the overall energy requirements of a continuous cross-flow plant. Tubular modules feature large diameters and wide channels, requiring high volumetric flow rates to generate turbulent conditions and control fouling. Pumping these large volumes demands significantly higher mechanical energy compared to compact spiral-wound configurations with narrow flow channels.

189. (B) The increased viscosity and altered fat-to-protein ratio.
Concentrating milk via ultrafiltration significantly increases the concentration of casein, altering the physical fat-to-protein ratio and raising milk viscosity. Homogenizing this highly viscous retentate requires substantial adjustments, such as reducing operating pressures or optimizing temperatures, to ensure effective fat globule dispersion and prevent rapid protein aggregation during the homogenization process.

190. (B) It removes spore-forming bacteria causing late-blowing defects without heat-denaturing coagulation-active proteins.
Using microfiltration for cold pasteurization of cheese milk selectively removes spore-forming bacteria like Clostridium tyrobutyricum, which cause late-blowing defects in ripened cheeses. This physical separation is achieved at low temperatures, ensuring that coagulation-active whey proteins and casein micelles undergo zero thermal denaturation. This preserves the milk's native coagulation properties and enhances cheese quality.

191. (A) The dynamic viscosity of the fluid
The Hagen-Poiseuille equation models laminar flow through cylindrical channels, stating that the volumetric flow rate is directly proportional to pressure drop and pore radius. Conversely, the equation shows that flow rate is inversely proportional to the dynamic viscosity of the fluid. Higher fluid viscosity increases frictional drag, thereby reducing transport rates through membrane pores.

192. (C) High osmotic pressure of concentrated milk limits total solids to well below spray drying requirements.
Using reverse osmosis alone to produce milk powder is impossible because concentrating milk solids raises osmotic pressure. At twenty-five to thirty percent solids, the osmotic pressure approaches seventy bar, which represents the practical limit for standard pumps and membranes. Evaporators are strictly required to concentrate the milk to fifty percent solids before spray drying.

193. (D) The physical dimensions of the capillary fibers are too small to house any structural inserts.
Hollow fiber membranes are fine capillaries with internal diameters of only 0.5 to 2.0 millimeters. These tiny physical dimensions make it impossible to insert structural turbulence promoters inside the fiber lumens. Therefore, hollow fiber modules must rely entirely on controlling fluid flow rates and velocities to generate the shear forces required to prevent fouling.

194. (C) Alpha-lactalbumin
Human breast milk has a much higher ratio of alpha-lactalbumin to other whey proteins compared to bovine milk, which contains abundant beta-lactoglobulin. When formulating infant formula, bovine whey is processed using selective membrane separation to enrich the alpha-lactalbumin fraction. This enrichment closely mimics the nutritional profile of human milk, reducing allergenicity.

195. (B) II, III, IV, I
Whey membrane fouling follows a distinct sequential mechanism during filtration. First, proteins rapidly adsorb onto the pristine membrane surface. This is followed by the establishment of concentration polarization as rejected solutes accumulate in the boundary layer. Over time, these solutes form a dense gel layer, which eventually consolidates, causing severe internal pore blocking.

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concentrate, which generates zero liquid whey drainage during subsequent cutting and molding steps, maximizing overall yield.

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exceed their solubility thresholds. This triggers crystallization directly on the membrane surface, causing rapid inorganic scaling that blocks water transport.

205. (B) I and III
Ultrafiltration is highly effective for traditional dairy products. It enables continuous shrikhand base production by concentrating milk solids before fermentation, and incorporating these retentates in yogurt manufacturing eliminates the need to add skim milk powder. However, using retentates in paneer yields a product with different rheology compared to traditional hot-acid coagulation.

206. (B) The isolation avoids isoelectric precipitation, which irreversibly collapses micellar structure.
Native micellar casein isolated via microfiltration exhibits superior solubility because the physical process avoids isoelectric precipitation. Traditional casein production precipitates casein by lowering pH to 4.6, which irreversibly collapses the micellar structure and removes bound calcium. Microfiltration maintains the proteins in their native state, preserving the open, water-soluble micellar structure and mineral balance.

207. (A) Eddy currents and localized mixing near the boundary layer.
Inserting turbulence promoters inside tubular membrane modules modifies fluid hydrodynamics by disrupting laminar flow. As fluid passes these physical structures, it undergoes continuous flow separation, generating eddy currents and localized mixing near the boundary layer. This localized turbulence increases solute back-transport into the bulk, reducing concentration polarization and stabilizing permeate flux.

208. (C) Adsorbed protein layer
During membrane processing of milk, protein foulants like beta-lactoglobulin adsorb onto the membrane surface. Proteins are stable in acidic conditions, meaning an acidic wash step fails to remove them. Conversely, alkaline cleaners like sodium hydroxide swell and hydrolyze proteins, rendering them highly soluble. Rapid removal during alkaline washing confirms the foulant was a protein layer.

209. (D) It remains near zero, allowing continuous washout of the target solute until depletion.
During extended diafiltration of whey, the membrane's retention coefficient for low molecular weight solutes like lactose and mineral salts remains near zero. This complete permeability allows these small solutes to pass freely into the permeate stream. Consequently, continuous addition of diawater sweeps these molecules out of the system, resulting in their progressive depletion.

210. (C) MF targets fat globules, bacteria, and large casein, while UF targets dissolved whey proteins.
Microfiltration and ultrafiltration separate milk components based on pore size differences. Microfiltration utilizes membranes with pore sizes from 0.1 to 10 micrometers, targeting large entities like fat globules, somatic cells, bacteria, and micellar casein. Ultrafiltration employs tighter pores to retain dissolved macromolecules like whey proteins while letting water, lactose, and salts pass.

211. (C) 5
The Volume Concentration Factor measures volume reduction during filtration. Under batch conditions, it is calculated as initial feed volume divided by final retentate volume. Since feed is five thousand liters and four thousand liters of permeate is removed, final retentate is one thousand liters. Dividing five thousand by one thousand yields a concentration factor of five.

212. (D) Adding diawater continuously to match permeate flux, maintaining a constant minimum retentate volume.
To maximize water efficiency during diafiltration, fresh diawater must be added continuously at the same rate that permeate is removed. This approach maintains a constant minimum retentate volume throughout the wash step. Continuous addition maintains the maximum concentration gradient of permeable impurities, achieving target depletion using significantly less water than batch dilution methods.

213. (A) Bacteria are larger than the membrane pores and are retained, while soluble proteins pass through.
Microfiltration removes bacteria from milk based on size exclusion. Bacterial cells are large, spanning 0.5 to 5.0 micrometers, whereas soluble whey proteins and individual casein molecules

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196. (D) Operating final stages at a slightly higher temperature within protein stability limits to lower viscosity.
As fluid concentration increases in the final stages of an ultrafiltration plant, retentate viscosity rises exponentially. To manage this viscosity and maintain sufficient flow velocity, final stages are operated at a slightly higher temperature. Elevating temperature decreases fluid viscosity, which increases solute diffusion rates and enhances permeate flux while remaining safely within protein stability limits.

197. (A) True fouling involves physiochemical interactions like adsorption that require chemical cleaning to remove.
Concentration polarization is a reversible hydrodynamic phenomenon where solutes accumulate adjacent to the membrane surface, dispersing immediately when pressure is removed. In contrast, true fouling involves physiochemical interactions, such as protein adsorption, mineral precipitation, or pore blocking. These strong chemical bonds attach foulants directly to the membrane, requiring chemical clean-in-place cycles to remove.

198. (C) The presence of free chlorine or strong oxidizers.
Polyamide reverse osmosis membranes are highly susceptible to chemical degradation by oxidizing agents. Free chlorine in the feed or wash water chemically attacks the amide nitrogen, cleaving the polymer chains and permanently destroying the active skin layer. To prevent premature membrane failure, free chlorine must be strictly monitored and neutralized prior to contact.

199. (A) MPC-85 provides a highly concentrated protein source with minimal lactose, making it ideal for low-carbohydrate nutritional formulations and adult nutrition powders.
The functional application of Milk Protein Concentrate is determined directly by its protein-to-lactose ratio. MPC-85 contains eighty-five percent protein and minimal lactose, making it highly valuable for low-carbohydrate nutritional formulations and adult nutrition powders. Conversely, MPC-50 contains far higher lactose levels, which are better suited for standard milk standardization and dairy-specific applications.

200. (D) Liters per hour per square meter
Permeate flux measures the rate of fluid transport across a membrane, representing the volume of permeate produced per unit of time per unit of membrane surface area. In industrial membrane systems, this performance metric is expressed in liters per hour per square meter, which allows standardized comparison across different plant sizes.

201. (B) Electrodialysis
Electrodialysis is an electrochemical membrane separation process that utilizes ion-exchange membranes to separate charged ions from uncharged species. Unlike pressure-driven operations like reverse osmosis, microfiltration, or nanofiltration, electrodialysis uses an electrical potential difference as the driving force. This electrical field pulls cations and anions through selective membranes, demineralizing the feed stream.

202. (C) Substantial quantities of dilute permeate containing lactose and minerals.
Producing high-protein isolates via ultrafiltration and diafiltration generates substantial quantities of liquid permeate as a byproduct. This dilute permeate stream contains water, lactose, and dissolved mineral salts. Since it represents a massive volume with significant organic load, managing this byproduct through concentration, lactose recovery, or anaerobic digestion is essential for environmental compliance.

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203. (D) The tight mesh of feed spacers creates physical dead zones where bacteria easily hide and form biofilms.
Spiral-wound modules are highly susceptible to biological fouling due to their internal design. The narrow feed channels contain mesh-like spacers that generate turbulence but also create physical dead zones. These stagnant regions allow bacteria to escape high-velocity shear, attach to the membrane surface, and form highly resistant biofilms that are difficult to clean.

204. (A) Rejected salts at the membrane surface will exceed their solubility limits, causing rapid inorganic scaling.
Operating a nanofiltration system at excessively high recovery rates raises the concentration of rejected salts at the membrane surface. As the retentate is highly concentrated, minerals like calcium phosphate and calcium sulfate

222. (B) The ratio increases as true proteins are retained while small non-protein nitrogen compounds pass into permeate.
Ultrafiltration selectively alters the composition of nitrogenous compounds in milk. True proteins like casein and whey proteins are large and fully retained by the membrane. Conversely, small non-protein nitrogen compounds like urea and amino acids pass freely into the permeate. This separation systematically increases the ratio of true protein to non-protein nitrogen in the retentate.

223. (A) Ceramic tubular channels are open and linear, lacking feed spacers that physically trap particulates and block flow.
Ceramic tubular membranes feature wide, open channels that are highly suitable for high particulate loads. Unlike spiral-wound systems, they contain zero mesh-like spacers that can trap solids and initiate blockages. This linear, open design allows particulate-rich fluids like whole milk or raw whey to flow freely, minimizing the risk of mechanical plugging and simplifying physical cleaning.

224. (C) To provide robust mechanical strength to withstand high operating pressures without impeding permeate flow.
A thin-film composite reverse osmosis membrane consists of an ultra-thin polyamide active layer cast on a porous support structure. The main function of the support layer, typically made of polysulfone, is to provide mechanical strength. This allows the membrane to withstand operating pressures up to eighty bar without tearing, while maintaining high water permeability.

225. (C) Only V
While back-pulsing is highly effective at physically removing consolidated gel layers and loose surface deposits, it is totally ineffective at reversing long-term chemical adsorption. Chemical adsorption involves strong hydrophobic and electrostatic interactions between proteins and the membrane polymer, which can only be broken down and resolved through targeted chemical clean-in-place cycles.

226. (C) It increases flux by decreasing fluid viscosity and increasing the solute diffusion coefficient.
Increasing bulk feed temperature enhances permeate flux through two thermodynamic mechanisms, assuming fouling remains constant. First, higher temperatures reduce the dynamic viscosity of the liquid, decreasing hydraulic flow resistance through the membrane pores. Second, elevated temperatures increase the solute diffusion coefficient, accelerating solute back-diffusion into the bulk and reducing concentration polarization.

227. (B) The required pore size allows passage of small casein micelles, reducing overall casein yield.
Concentrating micellar casein via microfiltration presents distinct challenges compared to ultrafiltration. The microfiltration membrane pore size must be selected to allow whey proteins to pass while retaining casein. However, casein micelles exist across a broad size distribution, and smaller micelles can pass through the pores into the permeate, reducing the overall casein yield.

228. (D) By increasing total solids, reducing the volume of water that must be trucked to central facilities.
Fluid whey contains ninety-three percent water, making direct transportation to centralized processing facilities highly uneconomical. Applying reverse osmosis on-site concentrates the solids from six to over twenty percent. Removing this large volume of water significantly reduces the total fluid weight, lowering shipping costs and reducing the carbon footprint of transport.

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229. (A) To force clean rinse water through membrane pores, purging chemical residues from the permeate side.
Maintaining a small transmembrane pressure during CIP rinsing steps is critical for complete chemical removal. This small pressure gradient forces clean rinse water to flow from the retentate side to the permeate side, flushing out any accumulated alkaline or acid chemical residues from the pores and permeate channels, preventing chemical contamination of subsequent products.

230. (C) It generates absolutely no liquid whey drainage from vats during coagulation and molding steps.
Standardizing cheese milk using ultrafiltration to produce a fully concentrated liquid pre-cheese retentate alters traditional cheese manufacturing. This retentate contains fat and casein in the exact ratios of the target cheese. Coagulation is performed directly on this

are smaller. Selecting a membrane with pore sizes of 1.4 micrometers retains bacteria, while allowing soluble proteins to pass into the permeate, achieving cold pasteurization without thermal denaturation.

214. (C) Its exceptional solubility and clarity at low pH (pH 3.0 - 3.5)
Whey Protein Isolate is highly valued in sports nutrition because of its unique physical properties. It exhibits exceptional solubility and optical clarity at low pH values, specifically between 3.0 and 3.5. This high acid stability prevents protein precipitation and sedimentation, allowing manufacturers to formulate clear, high-protein beverages without losing nutritional quality.

215. (C) I, II, and IV
Batch designs subject fluid milk to longer processing times and mechanical shear inside recirculation loops. Conversely, continuous multi-stage systems provide tight residence time distributions and gentler product handling. Single-pass systems are only practical when high concentration factors are achieved instantly, which is rare in standard dairy ultrafiltration operations due to high viscosity.

216. (D) Flexible chains may uncoil and snake through pores smaller than their nominal spherical diameter.
Molecular Weight Cut-Off assumes solute molecules are rigid, spherical entities. However, linear, highly flexible polymer chains do not maintain a spherical conformation. Under high operational pressures and shear forces, these flexible molecules can uncoil and snake through membrane pores that are physically smaller than their nominal spherical diameters, resulting in lower solute rejection.

217. (B) High rates of irreversible calcium phosphate precipitation and thermal denaturation of sensitive whey proteins.
Operating dairy membrane plants above sixty-five degrees Celsius is limited by heat-induced chemical changes. At high temperatures, dissolved calcium phosphate exhibits inverse solubility and precipitates rapidly, forming hard mineral scale. Simultaneously, sensitive whey proteins like beta-lactoglobulin undergo thermal denaturation, forming insoluble aggregates that irreversibly coat and foul the membrane surface.

218. (C) The ratio of actual pore channel length to membrane thickness, indicating path complexity.
In asymmetric polymeric membranes, tortuosity is a physical metric that quantifies the structural complexity of internal pore channels. It is defined as the ratio of the actual, curved pore channel path length to the nominal geometric thickness of the membrane. High tortuosity indicates a highly winding path, which increases flow resistance and reduces overall permeability.

219. (D) Hydrolysis alone converts lactose to sweeter glucose and galactose, whereas UF physically removes sugars to balance flavor.
Enzymatic hydrolysis alone is insufficient for low-lactose products because it cleaves lactose into glucose and galactose. These monosaccharides remain in the milk, doubling the molar concentration of sugars and significantly increasing sweetness. Combining hydrolysis with ultrafiltration physically removes a large portion of the sugars, allowing manufacturers to maintain a balanced sweetness and flavor profile.

220. (A) Exponential viscosity increases of concentrated casein limit pumpability and reduce flux to near zero.
During the production of Milk Protein Concentrate via ultrafiltration, concentrating casein micelles causes an exponential rise in retentate viscosity. As concentration factors increase, the fluid exhibits highly non-Newtonian flow behavior, which limits pumpability and increases mechanical pressure drops. This high viscosity limits mass transfer, reducing the permeate flux rate to unsustainable levels.

221. (B) Avoiding prolonged operation at excessive pressures and high temperatures that compress the polymer.
Membrane compaction is a mechanical phenomenon where asymmetric polymeric membranes undergo permanent physical deformation under high pressure. This structural compression collapses the porous support layer, increasing physical transport resistance and reducing permeability. To prevent compaction, operators must avoid prolonged runs at high transmembrane pressures and temperatures that exceed the polymer's thermal limits.

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CHAPTER 09
Dairy and Food Packaging

2017

1. What is the fundamental function of primary packaging in the food supply chain?
(A) To facilitate bulk handling and transportation of unitized goods
(B) To bundle multiple secondary packages for wholesale distribution
(C) To secure unitized loads on pallets for global shipping
(D) To protect the product directly and provide immediate containment

2009

2. Which of the following statements INCORRECTLY describes secondary packaging?
(A) It is the layer in direct contact with the food matrix
(B) It provides additional physical protection during handling
(C) It often groups multiple primary packages together
(D) It serves primarily as a display and collation unit

2018

3. Which combination of materials represents typical tertiary packaging components?
(A) Corrugated shipping boxes and glass containers
(B) Flexible aluminum foils and plastic laminates
(C) Stretch wrap, pallets, and plastic strapping
(D) Cylindrical metal cans and paperboard cartons

2015

4. Identify the correct pair regarding packaging levels and their examples.
(A) Primary packaging - Aluminum beverage can
(B) Primary packaging - Wooden pallet
(C) Secondary packaging - Milk carton
(D) Tertiary packaging - Corrugated shipping box

2001

5. Consider the following statements regarding packaging classifications:
I. Primary packaging contains the product directly.
II. Secondary packaging combines primary packages.
III. Tertiary packaging is used exclusively for consumer display.
Which of the statements given above are correct?
(A) I and II
(B) II and III
(C) I and III
(D) I, II and III

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2015

6. A manufacturer wants to group 24 individual beverage cans for retail display. Which packaging level is most appropriate for this purpose?
(A) Primary packaging
(B) Secondary packaging
(C) Tertiary packaging
(D) Quaternary packaging

2021

7. What is the main cause of physical damage that tertiary packaging aims to prevent during the dairy supply chain?
(A) Microbial contamination and biological decay
(B) Oxidative staling and excess moisture loss
(C) Vibration and shock during distribution
(D) Photolytic ultraviolet light degradation

2013

8. In the context of dairy packaging, which of the following is an advantage of a well-designed secondary package?
(A) It reduces the equilibrium modified atmosphere of the inner pack
(B) It completely prevents flavor scalping into the primary polymer
(C) It replaces the need for chemical preservatives and sterilants
(D) It improves retail shelf stocking and product brand visibility

2011

9. Which packaging level is least likely to require food-grade safety certifications?
(A) Tertiary packaging

oxygen barrier
(B) To provide an excellent vapor and moisture barrier
(C) To act as the primary structural heat-sealing layer
(D) To reduce the overall manufacturing cost of the film

2003
29. Which synthetic polymer is commonly avoided in direct food contact unless strictly plasticizer-free, due to migration concerns?
(A) Polyethylene
(B) Polypropylene
(C) Polyvinyl Chloride
(D) Polyethylene Terephthalate

2009
30. What defines the food-grade status of synthetic polymeric materials?
(A) Their inherent ability to naturally biodegrade in standard commercial landfill systems
(B) Their absolute lack of synthetic chemical stabilizers, colorants, and plasticizers
(C) Their exceptional optical clarity, surface gloss, and mechanical tensile properties
(D) Compliance with strict specific and overall toxicological migration limits

2016
31. Which mechanical test measures the maximum stress a packaging material can withstand while being stretched before breaking?
(A) Burst strength test
(B) Tear resistance test
(C) Tensile strength test
(D) Puncture resistance test

2024
32. What does the burst strength test primarily evaluate in paperboard packaging?
(A) Resistance to propagation of an existing cut
(B) Capacity to withstand internal hydrostatic pressure
(C) Force required to penetrate the material with a sharp object
(D) Elongation at break

2022
33. Which parameter is derived from the tensile testing curve of a packaging film?
(A) Mullen index
(B) Elmendorf tear strength
(C) Moisture vapor transmission rate
(D) Young's modulus

2022
34. Identify the correct statement regarding tear resistance in packaging materials.
(A) It evaluates the force required to propagate a pre-initiated tear
(B) It is measured using the hydraulic Mullen burst pressure tester
(C) It represents a synonymous concept to physical puncture resistance
(D) It measures the maximum internal hydrostatic pressure before rupture

2002
35. Consider the following steps for conducting a standard tensile strength test on a polymer film:
I. Clamping the specimen in the grips of the testing machine
II. Cutting the sample to a specific standard geometry (e.g., dumbbell shape)
III. Recording the force-elongation curve until fracture
IV. Pre-conditioning the sample at standard temperature and humidity
Which of the following represents the correct sequence of these steps?
(A) II, IV, I, III
(B) IV, II, I, III
(C) II, I, IV, III
(D) I, II, IV, III

2004
36. What is the fundamental difference between puncture resistance and tear resistance?
(A) Puncture evaluates resistance to probe penetration; tear measures slit propagation.
(B) Puncture evaluates slow tensile stretching; tear measures high-speed dynamic stretching.
(C) Puncture is suited only for rigid materials; tear is suited only for flexible films.
(D) Puncture requires a pre-notched test sample; tear evaluates completely whole sheets.

2009
37. Which unit is most commonly used to express burst strength?
(A) Newtons per millimeter ($\frac{N}{m}m$)
(B) Joules per square meter ($\frac{J}{m}^2$)
(C) Grams per mil ($\frac{g}{m}il$)
(D) Kilopascals (kPa)

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2024
19. A key advantage of using tin-free steel (TFS) over conventional tinplate is:
(A) Superior weldability and soldering capabilities for side seams
(B) Complete elimination of protective organic lacquer requirements
(C) Lower cost due to use of chromium/ chromium oxide coating
(D) Extremely light weight for equivalent structural tensile strength

2003
20. Which feature is most relevant to the use of aluminum in traditional food packaging?
(A) It is highly malleable and formed into seamless containers
(B) It exhibits strong magnetic properties useful for sorting
(C) It does not require any internal protective lacquer layers
(D) It degrades naturally in the open environment within weeks

2007
21. Which synthetic polymer is characterized by excellent clarity, good gas barrier properties, and is widely used for carbonated beverage bottles?
(A) Polypropylene (PP)
(B) Polyvinyl Chloride (PVC)
(C) Polystyrene (PS)
(D) Polyethylene Terephthalate (PET)

2018
22. Which food-grade standard is critically evaluated when using Polyvinyl Chloride (PVC) for food packaging?
(A) Leaching of bisphenol-A (BPA) residues directly into the food matrix
(B) Migration of unreacted monomer and added phthalate plasticizers
(C) Rapid breakdown of polymer chains into heavy metals during storage
(D) Spontaneous emission of volatile ethylene gas from the active film

2015
23. What structural feature distinguishes High-Density Polyethylene (HDPE) from Low-Density Polyethylene (LDPE)?
(A) HDPE has extensive short-chain and long-chain branching structures.
(B) HDPE incorporates rigid aromatic terephthalate rings in its backbone.
(C) HDPE possesses a highly linear structure with minimal branch chains.
(D) HDPE contains highly reactive chlorine atoms in its monomer backbone.

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2011
24. Which of the following polymers is most appropriate for hot-fill applications due to its relatively high melting point?
(A) LDPE
(B) Polystyrene (PS)
(C) PVC
(D) Polypropylene (PP)

2016
25. Match the synthetic polymers in List I with their typical packaging applications in List II:
List I: (Synthetic Polymers)
P. LDPE
Q. Polystyrene (PS)
R. Polyamide (Nylon)
S. PET
List II: (Packaging Applications)
1. Rigid transparent beverage bottles
2. Vacuum packaging films for meat
3. Flexible heat-sealable films
4. Thermoformed yogurt cups
(A) P-2, Q-3, R-1, S-4
(B) P-3, Q-4, R-2, S-1
(C) P-3, Q-1, R-4, S-2
(D) P-1, Q-4, R-2, S-3

2017
26. What makes Polystyrene (PS) particularly suitable for protective packaging foams and rigid dairy cups?
(A) Its high tensile elasticity and mechanical stretchability
(B) Its high capability for thermoforming and physical expansion
(C) Its outstanding barrier resistance against gaseous oxygen
(D) Its high chemical resistance to aggressive organic solvents

2003
27. Identify the INCORRECT statement regarding polymer characteristics.
(A) PET - Exceptional structural tensile strength
(B) Polyamide - Excellent moisture vapor barrier
(C) LDPE - Outstanding hermetic heat sealability
(D) PP - High thermal melting point resistance

2012
28. Why are polyamides (nylons) frequently used as a layer in multilayer packaging films?
(A) To provide puncture resistance and an

(B) Primary packaging
(C) Secondary packaging
(D) Edible packaging

2025

10. Based on the concept of unitization, what is the primary goal of tertiary packaging?
(A) To provide an absolute gas and oxygen barrier
(B) To consolidate unit loads for logistical handling
(C) To enhance individual consumer-facing aesthetics
(D) To display mandatory nutritional facts to consumers

2013

11. Which basic property makes glass an excellent traditional packaging material for liquid dairy products?
(A) Exceptional tensile strength and micro-porosity
(B) High inertness and absolute barrier properties
(C) Superior mechanical impact and shatter resistance
(D) Low density and highly lightweight elastic nature

2013

12. What is the primary function of the tin coating on a tinplate can used for food packaging?
(A) To prevent chemical corrosion of underlying steel
(B) To provide structural rigidity and mechanical strength
(C) To act as a complete filter against ultraviolet light
(D) To increase overall weight for handling line stability

2001

13. Which of the following is a significant disadvantage of using aluminum for rigid packaging?
(A) It is highly susceptible to atmospheric oxidation and red rust formation
(B) It offers extremely poor barrier properties against light transmission
(C) It has low structural strength without internal pressure or ribbing
(D) It cannot be recycled or reprocessed using standard industrial ovens

2002

14. What chemical process is primarily responsible for the manufacturing of paperboard from wood pulp?
(A) Polymerization
(B) Vulcanization
(C) Extrusion
(D) Kraft process

2010

15. Directions: The following question consists of two statements, one labeled as Assertion (A) and the other as Reason (R). Choose the correct option.
Assertion (A): Glass containers are less commonly used for large-volume, low-cost dairy distribution today.
Reason (R): Glass is chemically reactive with acidic dairy products, causing off-flavors.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2003

16. Identify the INCORRECT statement regarding traditional packaging materials.
(A) Tinplate involves a mild steel base coated with a thin layer of tin.
(B) Paper is inherently a strong barrier to water vapor and oxygen.
(C) Aluminum provides an excellent barrier to moisture and gases.
(D) Glass is completely impermeable to gases and vapors.

2021

17. Which traditional material is most frequently used for aseptic packaging laminates to provide a light and gas barrier?
(A) Glass
(B) Tinplate
(C) Kraft paper
(D) Aluminum foil

2021

18. What is the most appropriate treatment to improve the water resistance of paperboard for dairy applications?
(A) Lamination with polyethylene
(B) High-temperature annealing
(C) Electrochemical anodizing
(D) Thermal surface tempering

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2016
38. If a packaging film exhibits low tensile strength but high elongation at break, what is its likely behavioral characteristic?
(A) Highly hard and brittle
(B) Soft and highly stretchable
(C) Extremely stiff and rigid
(D) Highly hydraulic burst resistant

2015
39. Which device is traditionally associated with measuring the tear resistance of paper and plastic films?
(A) Instron universal testing machine
(B) Mullen burst tester
(C) Elmendorf tear tester
(D) Puncture probe

2025
40. Why is puncture resistance an essential mechanical test for vacuum-packaged meat products?
(A) To ensure that the film can stretch extremely tightly around the meat surface
(B) To measure the permeability rates of oxygen gas through the polymer structure
(C) To evaluate the surface printability and ink adhesion of the plastic vacuum bag
(D) To prevent sharp bone-in cuts from piercing the packaging during transit

2012
41. What does the Water Vapor Transmission Rate (WVTR) measure in packaging materials?
(A) The mass of water vapor passing through a unit area per unit time
(B) The volume of liquid water absorbed by the packaging material matrix
(C) The rate at which the solid packaging material dissolves in hot water
(D) The diffusion coefficient of water molecules within the polymer structure

2010
42. Which external factors critically influence the Oxygen Transmission Rate (OTR) of a polymer film?
(A) Material color and print quality
(B) Temperature and relative humidity
(C) Ambient lighting and sound vibration
(D) Tensile strength and elongation

2016
43. Which of the following polymers is recognized for having an exceptionally low WVTR, making it an excellent moisture barrier?
(A) Ethylene Vinyl Alcohol (EVOH)
(B) High-Density Polyethylene (HDPE)
(C) Polyamide (Nylon)
(D) Cellulose Acetate

2022
44. Identify the INCORRECT statement regarding barrier property evaluations.
(A) OTR measurements are independent of partial pressure gradients.
(B) WVTR is typically expressed in standard units of $g/m^2 \cdot day$.
(C) Permeability coefficients account directly for material thickness.
(D) EVOH loses its gas barrier properties under high humidity conditions.

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2011
45. Consider the following statements about barrier properties:
I. OTR measures the volume of oxygen gas passing through a specified area over time.
II. Aluminum foil has essentially zero WVTR and OTR if it is free of pinholes.
III. Hydrophilic polymers generally show improved gas barrier properties at high relative humidity.
IV. WVTR testing usually involves maintaining a specific humidity gradient across the sample.
Which of the statements given above are correct?
(A) I, II and IV
(B) I, III and IV
(C) II, III and IV
(D) I, II and III

2007
46. What is the fundamental principle of the gravimetric (cup) method for measuring WVTR?
(A) Measuring pressure changes inside a hermetically closed test chamber
(B) Using a coulometric sensor to detect permeating water molecules
(C) Observing the color change of cobalt chloride paper in a desiccator
(D) Monitoring weight changes of a desiccant inside a sealed test dish

2008
47. Which evaluation technique is predominantly used to determine the OTR of packaging films?
(A) Gravimetric desiccant method
(B) Elmendorf pendulum method
(C) Coulometric sensor method
(D) Mullen hydraulic method

2007

48. If a food product is highly susceptible to lipid oxidation, the chosen packaging material must prioritize:
(A) High OTR
(B) Low OTR
(C) High WVTR
(D) Low tensile strength

2025

49. How does increasing the thickness of a homogenous polymer film affect its absolute transmission rate (WVTR or OTR)?
(A) It increases the transmission rate proportionally.
(B) It has no effect on the transmission rate.
(C) It makes the transmission rate fluctuate randomly.
(D) It decreases the transmission rate.

2007

50. Which polymer combination represents a highly effective barrier structure for both oxygen and moisture?
(A) LDPE / EVOH / LDPE
(B) PS / Paper / PS
(C) PVC / PVC / PVC
(D) Polyamide / PET / Polyamide

2005

51. How are hot-melt adhesives primarily classified in food packaging?
(A) By their structural requirement for rapid water evaporation during joint setting
(B) By their reliance on toxic organic solvent evaporation within drying tunnels
(C) By their thermoplastic nature of melting when heated and setting when cooled
(D) By their thermosetting chemical cross-linking reactions under high pressure

2001

52. Which type of adhesive is generally preferred in flexible food packaging lamination due to environmental and safety concerns?
(A) Solventless or water-based polyurethane systems
(B) High-VOC solvent-based liquid adhesive systems
(C) Phenol-formaldehyde thermo-hardening resin systems
(D) Lead-stabilized epoxide polymer adhesive systems

2016

53. What is the primary functional mechanism of water-based adhesives during the bonding process?
(A) Free-radical polymerization triggered by ultraviolet light
(B) Rapid physical cooling from an elevated temperature molten state
(C) Covalent chemical reaction with functional groups on the substrate
(D) Evaporation or absorption of water from the liquid carrier system

2024

54. Identify the correct statement regarding solvent-based adhesives in food packaging.
(A) They are entirely free from volatile organic compounds (VOCs) during use.
(B) They require heating systems to dry out solvents before laminate bonding.
(C) They set rapidly by cooling to room temperature with zero mass transfer.
(D) They are specifically formulated to be biodegradable and fully edible.

2007

55. Directions: The following question consists of two statements, one labeled as Assertion (A) and the other as Reason (R). Choose the correct option.
Assertion (A): Hot-melt adhesives are widely used for sealing corrugated cartons in fast-moving packaging lines.
Reason (R): Hot-melt adhesives require extended drying times for water to evaporate, ensuring a strong bond.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2019

56. What is a primary limitation of using water-based adhesives on non-porous polymer films?
(A) The water carrier evaporates too rapidly before contact is established.
(B) They generate localized high heat that immediately melts plastic films.
(C) They trigger spontaneous catalytic combustion during film lamination.
(D) The water cannot easily escape non-porous films, slowing drying times.

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2013
57. Which component is typical in the formulation of hot-melt adhesives to provide tackiness?
(A) Tackifying resins
(B) Water carriers
(C) Ethyl acetates
(D) Starch binders

2025
58. In the context of food packaging adhesives, what does the term "green tack" refer to?
(A) The formal environmental certification of an adhesive system
(B) The initial bonding strength prior to full drying or curing
(C) The chemical tendency of the resin to turn green under UV light
(D) The dedicated use of adhesives for labeling fresh green produce

2019
59. Why is strict control of solvent retention necessary when using solvent-based adhesives for flexible food laminates?
(A) To prevent the flexible polymer film from becoming excessively rigid
(B) To avoid toxic solvent migration into food which causes off-flavors
(C) To artificially increase the gross weight of finished package systems
(D) To significantly enhance the oxygen transmission rate of laminates

2006
60. Which application predominantly utilizes water-based starch adhesives in the packaging industry?
(A) Manufacturing of corrugated paperboard structures
(B) Lamination of aluminum foil to plastic substrates
(C) Hermetic sealing of rigid plastic food containers
(D) Industrial assembly of hot-fill glass packaging

2010
61. Under FSSAI guidelines, which of the following is a mandatory declaration on packaged food labels?
(A) The exact recipe and proportion of all minor flavoring agents
(B) The legal name and personal contact details of marketing agency CEOs
(C) The list of food ingredients ordered descending by weight or volume
(D) The total lifecycle carbon footprint of the selected packaging film

2011
62. What is the primary purpose of the nutritional fact panel on a food package?
(A) To declare geographically specific agricultural origins of all raw ingredients
(B) To list potential allergen cross-contact risks within manufacturing plants
(C) To advertise non-verified functional medical health benefits of products
(D) To show energy values and standardized nutrient contents per typical serving

2008
63. Which printing technique is most commonly used for high-quality, high-volume flexible packaging films due to its excellent image reproduction?
(A) Flexography
(B) Screen printing
(C) Rotogravure
(D) Inkjet printing

2019
64. Identify the INCORRECT statement regarding labeling regulations in India.
(A) Veg/Non-Veg logos must be displayed prominently on the principal display panel.
(B) Net quantity can be declared in non-standard units if chosen by manufacturers.
(C) Date of manufacture along with best before/ expiry timelines are always mandatory.
(D) Nutritional details must explicitly disclose quantities of added sugars and trans fats.

2022
65. Match the printing and labeling terms in List I with their descriptions in List II:
List I: (Printing and Labeling Terms)
P. Flexography
Q. Principal Display Panel
R. Nutritional claim
S. Batch code
List II: (Descriptions)
1. Statement highlighting specific dietary properties (e.g., "Low Fat")
2. Uses flexible relief plates for printing on various substrates
3. The part of the label most likely to be seen by the consumer at the point of sale
4. Alphanumeric sequence for product traceability
(A) P-2, Q-3, R-1, S-4
(B) P-3, Q-2, R-4, S-1
(C) P-2, Q-4, R-3, S-1
(D) P-4, Q-1, R-2, S-3

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I. Photodegradation can lead to the "sunlight flavor" defect in fluid milk due to amino acid and riboflavin reactions.
II. Lipid oxidation kinetics typically follow a zero-order reaction phase indefinitely.
III. Moisture transfer can alter the glass transition temperature of packaged amorphous food powders.
IV. Oxygen scavengers in packaging can completely halt anaerobic microbial degradation.
V. The rate of oxidative degradation is directly proportional to the partial pressure of oxygen inside the package.

Which of the statements given above are INCORRECT?
(A) I and III
(B) II and IV
(C) III and V
(D) I and V

2002
86. Which characteristic of packaging material is most critical for protecting riboflavin in pasteurized milk?
(A) High structural mechanical puncture resistance
(B) Opacity or specific UV/visible light block
(C) Extremely low moisture vapor transmission rate
(D) High thermal conductivity during storage

2009
87. In the context of lipid oxidation, what role do transition metal contaminants (e.g., iron, copper) from poor packaging play?
(A) They act as powerful natural antioxidants to retard rancidity.
(B) They physically block oxygen from interacting with double bonds.
(C) They serve as catalysts for initiating free radical formation.
(D) They quickly convert unsaturated fatty acids into saturated fats.

2013
88. Moisture sorption isotherms are essential in packaging design to determine:
(A) The exact print density required for high-resolution product labels
(B) The tensile strength loss of polymer films when exposed to wet climates
(C) The chemical rate of photo-oxidation in transparent plastic bottles
(D) The critical moisture content at which food chemical quality deteriorates

2024
89. Which food component is highly susceptible to non-enzymatic browning (Maillard reaction) if moisture transfer increases the product's water activity to intermediate levels?
(A) Proteins and reducing sugars
(B) Long-chain storage lipids
(C) Pure crystalline sucrose
(D) Structural micro-cellulose

2005
90. What is the fundamental mechanism by which cushioning materials protect packaged foods during transit?
(A) By completely eliminating all external vibrational forces during delivery
(B) By absorbing kinetic energy and extending deceleration time during impact
(C) By increasing overall physical rigidity and density of the inner food
(D) By generating an opposing magnetic field to repel heavy physical shocks

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2010
91. Which testing protocol specifically evaluates a package's ability to withstand sudden impacts equivalent to falling off a forklift?
(A) Compression test
(B) Drop testing
(C) Vibration control test
(D) Climatic chamber test

2014
92. What phenomenon occurs when the natural frequency of a packaged product matches the excitation frequency of the transport vehicle?
(A) Resonance, which amplifies physical vibrations and causes damage
(B) Damping, which dissipates kinetic energy into low-grade heat
(C) Shock absorption, which eliminates mechanical impulse transfer
(D) Acoustic insulation, which blocks high-frequency air pressure

2013
93. Identify the correct statement about vibration control in protective packaging.
(A) Isolating cushions must be designed so their natural frequency equals transport frequency.
(B) Vibration-induced damage occurs exclusively in simple single-trip retail distribution chains.

IV. A photodiode detects the variations in reflected light intensity.

Which of the following represents the correct sequence of these events?

(A) II, III, IV, I
(B) II, IV, III, I
(C) I, II, III, IV
(D) III, II, I, IV

2022

76. What is the typical data capacity limit of a standard 1D EAN-13 barcode used in retail packaging?

(A) 13 numeric digits
(B) 13 alphanumeric characters
(C) Over 4000 alphanumeric characters
(D) 100 bytes of data

2010

77. Which of the following is a major advantage of laser coding over inkjet coding on packaging lines?

(A) It requires frequent and costly replenishment of ink and solvent.
(B) It creates easily erasable marks allowing simple code corrections.
(C) It creates permanent, indelible marks without using any consumables.
(D) It works perfectly on every transparent plastic film without exception.

2022

78. In a QR code structure, what purpose do the large distinct squares in three of the corners serve?

(A) They encode the underlying website URL and destination servers.
(B) They determine the overall color contrast of printed QR codes.
(C) They store the retail product pricing and inventory tax details.
(D) They act as position targets for high-speed 360-degree reading.

2001

79. Why is variable data coding essential in modern packaging logistics?

(A) To enhance the general visual appeal and branding of outer carton graphic prints
(B) To apply a hermetic seal directly to primary polymers during manufacturing
(C) To enable precise product traceability, recall control, and inventory tracking
(D) To monitor and measure internal temperature changes of pasteurized foodstuffs

2003

80. What specific degradation kinetic is primarily triggered by the absorption of UV/visible light in packaged foods?

(A) Non-enzymatic Maillard browning
(B) Photodegradation of riboflavin
(C) Retrogradation of cooked starch
(D) Enzymatic coagulation of proteins

2006

81. How does oxygen permeation through packaging primarily affect fat-rich foods like butter?

(A) It triggers widespread lactose crystallization inside the milk matrix.
(B) It initiates hydrolytic rancidity through enzymes present in fat.
(C) It reduces the mechanical hardness and physical stability of the butter.
(D) It promotes lipid auto-oxidation which directly yields bad off-flavors.

2008

82. Which kinetic model is often used to describe the temperature-dependent degradation rate of packaged foods?

(A) Arrhenius equation
(B) Stokes' law
(C) Fick's first law of diffusion
(D) BET isotherm

2024

83. What is the consequence of uncontrolled moisture transfer into a packaged hygroscopic dry food (e.g., milk powder)?

(A) Severe loss of volatile flavor components
(B) Decreased water activity and shelf stability
(C) Powder caking, clumping, and microbial growth
(D) Photochemical bleaching of food pigments

2014

84. Identify the INCORRECT statement linking a degradation mechanism to its primary packaging-related cause.

(A) Caking of powders - Low Water Vapor Transmission Rate (WVTR)
(B) Lipid oxidation - High Oxygen Transmission Rate (OTR)
(C) Vitamin degradation - Transparent packaging exposed to light
(D) Staling of baked goods - Moisture loss through packaging

2006

85. Consider the following statements regarding the degradation kinetics of packaged foods:

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2012

66. How does FSSAI mandate the declaration of food additives on packaging labels?
(A) By functional class with specific names or standard INS codes
(B) By proprietary commercial brand or trade names exclusively
(C) By structural chemical IUPAC molecular formulas on label
(D) By omitting any auxiliary additives present below the 1% limit

2007

67. Which of the following is considered a statutory requirement for the labeling of irradiated foods under FSSAI?
(A) A standardized green square-in-circle logo
(B) Only the calendar date of the radiation process
(C) The Radura logo with a specific written declaration
(D) A stark warning statement regarding radioactivity

2025

68. What role does flexography play in modern food packaging?
(A) It uses liquid inks and flexible photopolymer plates for plastic substrates.
(B) It carves heavy graphic images directly into copper cylinders for long runs.
(C) It relies on static electrical charges to transfer dry color toner particles.
(D) It is exclusively reserved for stamping simple numeric batch tracking codes.

2004

69. Which factor is most crucial when selecting inks for food packaging printing?
(A) They must wash off easily with simple tap water during container recycling.
(B) They must contain high concentrations of heavy metals to ensure bright color.
(C) They must permeate synthetic packaging barriers to dye outer food surfaces.
(D) They must feature low chemical migration potential to prevent contamination.

2015

70. What is the fundamental mechanical difference between 1D barcodes and 2D Quick Response (QR) codes?
(A) 1D codes use colored squares; 2D codes use black and white parallel lines.
(B) 1D codes store data in linear lines; 2D codes use a grid of square modules.
(C) 1D codes require live internet access; 2D codes read offline automatically.
(D) 1D codes hold significantly more alphanumeric data than modern 2D codes.

2018

71. Which coding technology has a significantly higher data capacity, allowing for the inclusion of website URLs and detailed batch histories?
(A) UPC-A Barcode
(B) EAN-13 Barcode
(C) 2D QR Code
(D) Interleaved 2 of 5

2011

72. What is the primary function of a Continuous Inkjet (CIJ) printer in packaging lines?
(A) To print complex full-color brand graphics on outer secondary corrugated cartons
(B) To permanently engrave identification tracking codes directly into glass surfaces
(C) To apply physical pressure-sensitive adhesive labels onto fast-moving bottles
(D) To print non-contact variable data like expiry dates and lot codes at high speed

2025

73. Identify the correct statement regarding 2D QR codes in packaging.
(A) They feature built-in error correction, remaining readable if partially damaged.
(B) They can only be read sequentially in a single direction from left to right.
(C) They are highly sensitive to dirt, failing completely if a single spot is hidden.
(D) They are strictly limited by design to encoding simple numeric digits only.

2025

74. Which coding method relies on localized heating to create a mark directly on a specialized substrate or ribbon?
(A) Non-contact CO_2 laser coding systems
(B) Thermal Transfer Overprinting (TTO)
(C) Continuous Inkjet (CIJ) print systems
(D) Drop-on-Demand (DOD) valve systems

2002

75. Consider the following events in the optical scanning process of a 1D barcode:
I. The decoder converts the light pattern into electrical signals representing data.
II. A light source (e.g., laser) sweeps across the printed barcode.
III. The dark bars absorb light while the light spaces reflect it back.

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(C) Damping materials dissipate kinetic energy, lowering physical amplitude at resonant states.
(D) Rigid steel structural brackets provide the absolute best dampening effects for fragile foods.

2024
94. Which of the following materials is most commonly used for its excellent multi-directional shock absorption and cushioning properties?
(A) Solid high-density polyethylene sheet
(B) Unfluted kraft paper
(C) Glassine paper
(D) Expanded polystyrene (EPS) foam

2014
95. Directions: The following question consists of two statements, one labeled as Assertion (A) and the other as Reason (R). Choose the correct option.
Assertion (A): Drop testing is performed from varying heights depending on the gross weight of the package.
Reason (R): Lighter packages are typically subjected to higher free-fall drops during manual handling than very heavy, palletized loads.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2005
96. What is the primary purpose of a fragility curve (damage boundary curve) in protective packaging design?
(A) To map standard expiration dates and bacterial decay curves of fragile products
(B) To define critical velocity and peak acceleration levels products can withstand
(C) To show physical Elmendorf tear resistance values of flexible lamination films
(D) To calculate precise volumetric quantities of hot-melt adhesives for cartons

2009
97. In a cushioning material, what does "creep" refer to during long-term storage?
(A) The physical migration of plasticizers from polymer layers into foods
(B) The slow growth of mold and bacterial colonies on wet paper surfaces
(C) The mechanical tendency of unitized cargo to slide off wooden pallets
(D) The gradual loss of foam thickness under a constant static weight load

2007
98. How do air bubble wraps achieve their protective cushioning effect?
(A) By compression of entrapped air cells upon physical impact
(B) Through high mechanical density of the polymer film backing
(C) By reflecting dynamic shockwaves using static electrical fields
(D) By physically expanding further in volume upon external impact

2001
99. Which drop test sequence is standard for evaluating a rectangular carton?
(A) Flat drops performed exclusively on top and bottom faces
(B) Rolling the package box down a long inclined metal ramp
(C) A specific drop sequence of corners, edges, and flat faces
(D) Dropping heavy external weights directly onto a static box

2015
100. What is a primary requirement for the packaging of fluid pasteurized milk to maintain shelf life?
(A) Protection from ultraviolet light and ambient chemical contaminants
(B) Capability to withstand high thermal retort sterilization temperatures
(C) Extremely high oxygen and carbon dioxide permeability through films
(D) Inclusion of active ethylene and moisture scavengers inside packs

2023
101. Which specific packaging characteristic is crucial for fermented dairy products like yogurt with live active cultures?
(A) Complete vacuum sealing to prevent all biochemical microbial activities inside
(B) Transparent packaging to allow ambient sunlight to stimulate culture growth
(C) Highly alkaline internal container coatings that neutralize organic residues
(D) Material resistance to lactic acid with barriers to prevent desiccation

2006
102. What is the primary function of parchment paper or aluminum foil wraps in traditional butter packaging?

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(A) To prevent light-induced lipid oxidation and external odor absorption
(B) To allow the inner butter matrix to breathe and dry out continuously
(C) To promote rapid enzymatic cheese-like ripening inside cold stores
(D) To provide a highly rigid, load-bearing structure for pallet stacks

2019
103. In aseptic packaging of UHT milk, what sterilant is predominantly used to sterilize the packaging material (e.g., carton roll stock) before filling?
(A) Concentrated sodium hypochlorite
(B) Pressurized sulfur dioxide gas
(C) Heated gaseous hydrogen peroxide
(D) Highly reactive gaseous ozone

2016
104. Which of the following is a common issue when packaging natural cheese that produces gas (like Swiss cheese)?
(A) The cheese requires a perfect absolute vacuum seal to retain moisture and taste.
(B) The packaging must absorb all surface milk lipids to prevent rancidity defects.
(C) The cheese completely stops releasing carbon dioxide gas once it is packaged.
(D) The package requires moisture barriers while letting carbon dioxide gas escape.

2005
105. Match the dairy products in List I with their specific packaging considerations in List II:
List I: (Dairy Products)
P. UHT Milk
Q. Butter
R. Natural Swiss Cheese
S. Ice Cream
List II: (Specific Packaging Considerations)
1. Requires low temperature resistance and moisture-loss prevention
2. Requires aseptic filling into sterile multilayer laminates
3. Requires protection against UV light, oxygen, and odor absorption
4. Requires a film capable of handling carbon dioxide evolution
(A) P-2, Q-3, R-4, S-1
(B) P-3, Q-1, R-4, S-2
(C) P-1, Q-4, R-2, S-3
(D) P-2, Q-4, R-3, S-1

NODIA

2021
106. What defines the basic principle of aseptic packaging?
(A) Packaging unsterilized food into clean containers under ambient open conditions.
(B) Packaging sterile product into sterile containers under aseptic conditions.
(C) Sterilizing the food and the package simultaneously inside an autoclave unit.
(D) Adding massive doses of preservatives directly to unsterilized packaging films.

2004
107. Which component in a standard aseptic carton laminate (e.g., Tetra Pak) provides the primary barrier against oxygen and light?
(A) Polyethylene
(B) Aluminum foil
(C) Paperboard
(D) Polypropylene

2004
108. Why is modified atmosphere packaging (MAP) often utilized for shredded cheese?
(A) To replace oxygen with N_2 and CO_2 to inhibit mold growth and clumping
(B) To accelerate chemical lipid oxidation reactions in free milk fats
(C) To encourage aerobic bacterial fermentation during cold logistics
(D) To significantly reduce overall manufacturing costs of raw materials

2023
109. What is the structural role of the paperboard layer in an aseptic milk carton?
(A) Complete liquid and moisture barrier
(B) Hermetic oxygen and gas block barrier
(C) Mechanical rigidity and shape retention
(D) Non-toxic direct food contact layer

2015
110. What is the primary purpose of Modified Atmosphere Packaging (MAP) for food products?
(A) To accelerate natural physiological ripening of fresh fruits indefinitely
(B) To create a complete, absolute vacuum around perishable processed meats
(C) To freeze food products without using energy-intensive refrigeration
(D) To alter internal gaseous environments specifically to extend shelf life

2017

111. Which gas is commonly used in MAP to displace oxygen and act as an inert filler to prevent package collapse?
(A) Carbon dioxide (CO_2)
(B) Oxygen (O_2)
(C) Nitrogen (N_2)
(D) Argon (Ar)

2009

112. What is the specific functional role of Carbon dioxide (CO_2) in a MAP gas mixture?
(A) It prevents chemical oxidation of oxymyoglobin red meat pigments.
(B) It dissolves in water to inhibit aerobic bacteria and mold growth.
(C) It acts as a non-reactive inert filler gas to prevent collapsing.
(D) It maintains the crispy structural texture of dehydrated dry foods.

2012

113. Under what specific condition is a high concentration of Oxygen (O_2) intentionally used in MAP?
(A) For packaging roasted coffee beans to tightly retain volatile aromas
(B) For packaging hard cheese to prevent anaerobic mold and yeast growth
(C) For packaging fried potato chips to prevent oxidative oil rancidity
(D) For packaging fresh red meat to maintain bright oxymyoglobin color

2002

114. Identify the INCORRECT statement regarding Equilibrium Modified Atmosphere (EMA) packaging.
(A) EMA is exclusively used for non-respiring processed meats.
(B) It relies on the interplay between the respiration rate of the fresh produce and the permeability of the packaging film.
(C) The goal is to reach a steady-state gas composition that minimizes respiration without causing anaerobic fermentation.
(D) Micro-perforated films are often used to achieve the desired gas transmission rates.

2003

115. Consider the following statements about MAP gases:
I. N_2 is highly soluble in water and fat, causing package shrinkage.
II. CO_2 exhibits significant fungistatic and bacteriostatic properties.
III. High O_2 is used in fresh red meat packaging.
Which of the statements given above are correct?
(A) I and II
(B) II and III
(C) I and III
(D) I, II and III

2021

116. In the Modified Atmosphere Packaging (MAP) of fresh bakery products, what is the most appropriate gas mixture to prevent mold growth while avoiding off-flavors?
(A) High CO_2 (e.g., 60%) balanced with N_2
(B) High O_2 (e.g., 100%) without inert gases
(C) 100% Carbon monoxide to inhibit oxidation
(D) Standard atmospheric air without alteration

2018

117. What problem occurs if the CO_2 concentration is excessively high in the Modified Atmosphere Packaging (MAP) of high-moisture foods without a structural filler gas?
(A) Rapid package swelling and eventual seam bursting
(B) Accelerated lipid oxidation and rancidity of fats
(C) Package collapse due to CO_2 dissolving into the food
(D) Extreme discoloration and bleaching of food pigments

2002

118. Which concept is crucial when designing Modified Atmosphere Packaging (MAP) for fresh, actively respiring fruits and vegetables?
(A) Matching film oxygen permeability to the product's respiration rate
(B) Total elimination of oxygen to maintain anaerobic conditions
(C) Utilizing absolute barrier packaging materials like aluminum foil
(D) Flushing the package headspace entirely with pure 100% CO_2

2003

119. What is a key limitation of using high concentrations of CO_2 in the Modified Atmosphere Packaging (MAP) of fluid dairy products or high-water foods?
(A) Significant encouragement of rapid aerobic spoilage organisms
(B) Severe discoloration that turns the product a bright red color
(C) Accelerated enzymatic browning reactions on food surfaces

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(D) Development of sour off-flavors from carbonic acid formation

2014

120. Which polymer physics principle governs the functionality of shrink wrapping films?
(A) Polymer chain entanglement and artificial plasticization under pressure
(B) Thermal orientation during manufacture and shape recovery upon heating
(C) Rapid chemical cross-linking of polymer chains upon exposure to UV light
(D) Accelerated crystallization of polymer phases upon rapid sudden cooling

2007

121. What happens to a shrink film at a molecular level when it is passed through a heat tunnel?
(A) Polymer chains completely break down into individual volatile monomers
(B) The film undergoes an irreversible thermosetting reaction to become rigid
(C) Oriented polymer chains release stress and revert to a random coiled state
(D) The polymer matrix rapidly absorbs atmospheric moisture and swells up

2017

122. Which property is characteristic of stretch wrapping rather than shrink wrapping?
(A) Direct requirement of a high-temperature heat tunnel for proper application
(B) Typical utilization of polyolefin films characterized by high heat-shrink ratios
(C) Permanent embrittlement of the polymer matrix shortly after application
(D) Inherent elastic recovery after being mechanically tensioned around a load

2004

123. Which polymer is predominantly used for pallet stretch wrapping due to its high elongation, tear resistance, and cling properties?
(A) Linear Low-Density Polyethylene (LLDPE)
(B) High-Impact Polystyrene (HIPS)
(C) Amorphous Polycarbonate (PC)
(D) Regenerated Cellulose Film (Cellophane)

2003

124. Identify the correct pair linking the wrapping technology to its typical primary application.
(A) Shrink wrapping - Unitizing entire pallets of heavy bricks without heat
(B) Shrink wrapping - Tamper-evident neck bands on sauce bottles
(C) Stretch wrapping - Tight collation of multipack consumer goods (e.g., twin packs of juice) requiring heat
(D) Stretch wrapping - Individual candy wrappers

NODIA

2002

125. Arrange the following procedural steps for applying a shrink wrap to a multipack of dairy products in the correct sequential order:
I. Passing the loosely wrapped product through a heated tunnel
II. Cutting and sealing the film to form a loose sleeve around the product
III. The film shrinks tightly around the contour of the products
IV. Feeding the product into the shrink wrapping machine
Which of the following represents the correct sequence?
(A) IV, II, I, III
(B) II, I, IV, III
(C) IV, I, II, III
(D) I, II, III, IV

2022

126. What does the "shrink ratio" of a film indicate?
(A) The percentage dimensional reduction of the film under unrestricted heat
(B) The cumulative percentage of visible light blocked by the polymer layers
(C) The numerical ratio of the film's cross-sectional thickness to its width
(D) The certified mass percentage of post-consumer recycled content in the film

2021

127. In stretch wrapping, what is the purpose of adding "tackifiers" or utilizing specific polymer blends?
(A) To significantly increase the polymer's thermal shrinking speed under heat
(B) To render the stretch film completely opaque and resistant to light transmission
(C) To provide cling so film layers stick to themselves without adhesive
(D) To substantially increase the tensile rigidity and stiffness of the plastic

2011

128. Which of the following is a significant logistical advantage of using stretch wrapping for pallet unitization?
(A) It continuously sterilizes the exterior surfaces of the secondary corrugated cartons
(B) It significantly reduces cost by requiring

substantial thermal energy input to set
(C) It provides a perfect, airtight hermetic barrier seal against atmospheric oxygen
(D) It stabilizes the load against shifting and vibration without requiring heat

2001
129. What is the fundamental thermodynamic principle behind self-heating packaging systems?
(A) Harnessing controlled endothermic dissolution reactions
(B) Employing thin-film microwave susceptor materials
(C) Utilizing controlled exothermic chemical reactions
(D) Utilizing latent heat of vaporization during cooling

2012
130. Which chemical reaction is most commonly utilized in commercial self-heating beverage cans?
(A) Gas-phase combustion of pressurized propane
(B) Hydration of quicklime ($CaO + H_2O \rightarrow Ca(OH)_2$)
(C) Direct neutralization of strong liquid acids and bases
(D) Accelerated atmospheric oxidation of fine iron powder

2016
131. In a self-heating can using calcium oxide, what triggers the heating process?
(A) Direct prolonged exposure of the can surface to ambient sunlight
(B) Shaking the container vigorously to generate internal friction heat
(C) Striking an external match or sparking mechanism on the lid
(D) Puncturing an internal barrier to mix water with the CaO

2024
132. What is the primary chemical mechanism employed in self-cooling beverage cans?
(A) Endothermic dissolution of salts or evaporation of compressed liquids
(B) Exothermic hydration of anhydrous salts under high mechanical pressure
(C) Direct atmospheric sublimation of solid carbon dioxide or dry ice blocks
(D) Thermoelectric Peltier cooling utilizing external battery-powered currents

2006
133. Which of the following is a significant design challenge in self-heating packaging?
(A) Ensuring the chemical reaction generates sufficient oxygen to carbonate the beverage
(B) Preventing the food matrix from freezing during low temperature external storage
(C) Managing heat transfer to food while preventing burns and conserving space
(D) Maintaining high optical transparency and clarity of the outer packaging layers

2023
134. Identify the INCORRECT statement regarding self-heating/cooling packaging.
(A) The CaO + water reaction is endothermic.
(B) The reaction module significantly reduces the volume of the product that can be contained in a standard-sized can.
(C) Insulation is required on the exterior of a self-heating can to protect the user's hands.
(D) They are considered "active packaging" systems.

2019
135. Analyze the Assertion (A) and Reason (R) given below, and select the correct option.
Assertion (A): Self-cooling cans based on the evaporation of compressed refrigerants have faced environmental and regulatory scrutiny.
Reason (R): The release of certain greenhouse gases or VOCs into the atmosphere during the cooling process is detrimental to the environment.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

NODIA

2009
136. Why is aluminum typically preferred over plastic for the inner compartment separating the food from the heating/cooling reagents?
(A) Because it is significantly cheaper to manufacture and process at scale
(B) Because of its high thermal conductivity, which enables rapid heat transfer
(C) Because it reacts chemically with calcium oxide to generate additional heat
(D) Because it allows the packaging to remain visually clear and transparent

2002
137. Which application is the primary target market for self-heating packaging technologies?

undesirable fishy amine off-odors
(C) To significantly increase and preserve the physical crispiness of potato chips
(D) To scavenge residual atmospheric oxygen directly from fresh meat packages

2007
189. How does a UV-activated oxygen scavenging polymer film function?
(A) It continuously reflects ambient UV light to prevent oxidative photodegradation
(B) It requires a dose of UV light during the packaging process to trigger a photo-oxidation reaction that subsequently consumes oxygen inside the package
(C) It changes color and turns dark when exposed to high-energy ultraviolet light
(D) It actively absorbs oxygen only when the package is placed in direct sunlight

2017
190. What defines "intelligent or smart packaging" compared to active packaging?
(A) It actively removes atmospheric oxygen from the internal package headspace
(B) It senses and provides information about the food's condition or environment
(C) It is formulated from biological polymers and is always completely edible
(D) It automatically self-heats or self-cools the food product upon consumer demand

2003
191. What does a Time-Temperature Indicator (TTI) monitor on a food package?
(A) The cumulative exposure to time and temperature, reflecting thermal abuse
(B) The precise real-time physical weight of the packaged product over storage
(C) The remaining concentration and volume of gaseous oxygen inside the headspace
(D) The absolute relative humidity levels of the external storage environment

2017
192. Which working principle is commonly used in enzymatic TTIs?
(A) The physical melting of a specialized dyed wax at a specific temperature
(B) The volumetric expansion of a liquid metal alloy inside a micro-capillary
(C) A temperature-dependent enzymatic reaction causing a visible color change
(D) The continuous gas-phase sublimation of solid dry ice within the indicator

2017
193. What is the primary function of a freshness sensor in intelligent packaging for meat?
(A) To continuously monitor and record the external ambient storage temperature
(B) To accurately measure and analyze the physical thickness of the cut of meat
(C) To actively track the real-time geographic location of the package via GPS
(D) To detect volatile spoilage metabolites and display a visible color change

2023
194. Which type of indicator is critical in verifying the integrity of Modified Atmosphere Packaging (MAP)?
(A) A time-temperature indicator to track historical thermal abuse profiles
(B) A visual ripeness indicator that senses volatile plant ripening hormones
(C) A leak indicator that changes color when exposed to atmospheric oxygen
(D) An electronic RFID tag that communicates inventory status wirelessly

2016
195. Identify the INCORRECT statement regarding intelligent packaging systems.
(A) TTIs are particularly useful for cold-chain monitoring of perishable dairy products.
(B) Intelligent packaging systems are designed to chemically preserve the food.
(C) Freshness sensors provide a direct indication of product quality rather than just environmental history.
(D) Leak indicators visually confirm if a hermetic seal has been breached.

2022
196. Consider the following statements about smart packaging:
I. A TTI visually indicates if a product has experienced temperature abuse during transport.
II. Oxygen indicators in MAP are usually formulated with redox dyes like methylene blue.
III. Freshness sensors cannot detect bacterial metabolites.
IV. RFID tags are a form of intelligent packaging used for logistics and traceability.
V. Intelligent packaging absorbs ethylene to delay ripening.
Which of the above statements are correct?
(A) I, II and IV

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sterilization
(A) P-3, Q-2, R-4, S-1
(B) P-2, Q-3, R-1, S-4
(C) P-4, Q-1, R-2, S-3
(D) P-1, Q-4, R-3, S-2

2007
146. What specific pressure control mechanism is required during the cooling phase of retort pouch sterilization?
(A) Immediate release of all internal vessel pressure to quickly drop the temperature of the chamber
(B) Maintaining overriding air pressure to prevent pouch rupture as internal steam condenses
(C) Application of a hard continuous vacuum to extract remaining moisture from the outer surfaces
(D) Flooding the entire sterilization chamber with highly pressurized oxygen-free nitrogen gas

2017
147. Why are aluminum-free, high-barrier transparent retort pouches (using materials like SiO_x or AlO_x coated PET) gaining popularity?
(A) They process significantly faster than traditional foil-based pouches
(B) They are much cheaper and simpler to produce on standard forming machinery
(C) They offer vastly superior light blocking capability compared to pure aluminum
(D) They provide product visibility and are completely microwave-safe

2024
148. Which defect in a retort pouch seal is most critical to detect prior to thermal processing?
(A) Channel leakers or product contamination in the seal zone
(B) Minor ink smudging and cosmetic errors on the outer PET layer
(C) Slight aesthetic wrinkling across the main body of the pouch
(D) Excessively glossy surface finish on the outer plastic layer

2013
149. What is the defining characteristic of a "microwave-transparent" packaging material?
(A) It actively absorbs ambient microwave energy to indirectly transfer heat to the food product
(B) It highly reflects incoming microwave electromagnetic energy completely away from the food
(C) It permits microwaves to pass through with minimal absorption, heating food directly
(D) It undergoes a physical phase change to turn completely invisible within the microwave chamber

NODIA

2018
150. Which polymer is widely considered excellent for microwave-transparent rigid containers due to its high heat deflection temperature and lack of polar groups?
(A) Polypropylene (PP)
(B) Low-Density Polyethylene (LDPE)
(C) Polyvinyl Chloride (PVC)
(D) Polystyrene (PS)

2011
151. What is the specific function of a microwave susceptor in food packaging?
(A) To shield delicate food portions from cooking too fast and drying out during the cycle
(B) To continuously measure and display the internal temperature of the microwave oven cavity
(C) To slowly release trapped moisture to steam the food and maintain a moist texture inside
(D) To convert microwave energy to sensible heat for localized browning and crisping

2006
152. How is a typical microwave susceptor constructed?
(A) A heavy, thick block of solid cast iron positioned directly inside the secondary packaging
(B) A thin, metallized aluminum layer deposited on a high-temperature PET substrate
(C) A pressurized layer of pure liquid water trapped securely between two plastic sheets
(D) Solid, dense carbon blocks glued directly to the interior walls of the paperboard carton

2012
153. Identify the correct statement regarding microwave shielding in packaging.
(A) Shielding is designed to make the food crispy.
(B) Shielding accelerates the cooking process by reflecting energy inward.
(C) Shielding uses thick metal foil to block microwaves, preventing localized overcooking
(D) Shielding uses microwave-transparent plastics.

2004

172. Which protein is frequently utilized to create transparent, flexible edible films with excellent oxygen barrier properties (at low humidity)?
(A) Tallow
(B) Whey protein isolate
(C) Pectin
(D) Cellulose

2014

173. What is the primary purpose of adding a plasticizer (like glycerol or sorbitol) to a polysaccharide-based edible film formulation?
(A) To significantly increase the mechanical rigidity and brittleness of the film
(B) To enhance film flexibility and handling by lowering intermolecular forces
(C) To act as a powerful broad-spectrum antimicrobial agent against active pathogens
(D) To make the resulting polysaccharide film completely waterproof and hydrophobic

2018

174. Identify the correct statement regarding polysaccharide-based edible films.
(A) They typically provide good gas barriers but exhibit poor moisture barriers
(B) They offer highly excellent, superior moisture barriers under all humid conditions
(C) They cannot be consumed safely by humans and must be manually peeled off the food
(D) They exhibit a completely hydrophobic nature and are highly insoluble in water

2022

175. Match the edible film components in List I with their primary functional characteristics in List II, and select the correct option.
List I: (Edible Film Components)
P. Beeswax
Q. Glycerol
R. Chitosan
S. Whey protein
List II: (Functional Characteristics)
1. Serves as a plasticizer to improve flexibility
2. Provides structural integrity and an oxygen barrier
3. Provides excellent moisture barrier but poor mechanical strength
4. A polysaccharide that offers inherent antimicrobial properties

(A) P-3, Q-1, R-4, S-2
(B) P-2, Q-3, R-1, S-4
(C) P-1, Q-4, R-2, S-3
(D) P-4, Q-2, R-3, S-1

2019

176. Which method is most commonly used to apply an edible coating to whole fresh fruits like apples to reduce transpiration and impart gloss?
(A) Direct high-pressure extrusion of a solid plastic film onto the fruit
(B) Vacuum-assisted physical deposition of volatile monomers in a chamber
(C) Direct thermal lamination of pre-formed polymer sheets on the product
(D) Dipping or spraying the liquid emulsion onto food, followed by drying

2011

177. How do composite edible films attempt to optimize packaging performance?
(A) By completely removing all plasticizing agents to increase film stiffness and hardness
(B) By blending highly synthetic non-degradable PVC polymers directly with natural corn starch
(C) By combining lipids and proteins to leverage the unique barrier properties of both
(D) By utilizing exclusively a single, highly purified and isolated plant-derived protein

2022

178. Why does the sorption of food components (like essential oils or fats) into a polymer sometimes negatively impact the package's integrity?
(A) Sorbed molecules act as plasticizers, causing swelling, loss of barriers, and weak seals
(B) It significantly increases the overall physical mass, making the package too heavy to transport
(C) It triggers chemical reactions that permanently freeze and crystallize the polymer structure
(D) It leads to highly volatile chemical reactions that cause immediate spontaneous combustion

2015

179. Which edible coating material is derived from the exoskeletons of crustaceans and exhibits unique inherent antimicrobial properties?
(A) Zein
(B) Chitosan
(C) Carrageenan
(D) Gum Arabic

2017

180. What defines "active packaging" in contrast to traditional passive packaging?
(A) It relies solely on high-barrier synthetic materials to passively protect food products

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2011

163. What is the primary mechanism of degradation for PLA in an industrial composting environment?
(A) Direct photodegradation and chemical bond cleavage initiated by ultraviolet sunlight
(B) Rapid mechanical fragmentation into stable, non-degradable polymer microplastics
(C) Direct oxidative degradation of the polymer backbone by atmospheric gaseous oxygen
(D) Initial thermal hydrolysis triggered by moisture, followed by microbial assimilation

2024

164. Identify the INCORRECT pair linking a biopolymer to its origin.
(A) Polycaprolactone (PCL) - Extracted directly from marine algae
(B) Polylactic Acid (PLA) - Fermentation of plant carbohydrates
(C) Polyhydroxyalkanoate (PHA) - Intracellular bacterial biosynthesis
(D) Natural Cellulose - Plant structural tissues and fiber matrices

2015

165. Analyze the Assertion (A) and Reason (R) given below, and select the correct option.
Assertion (A): While PLA is derived from renewable resources, it generally requires industrial composting conditions to biodegrade effectively within a reasonable timeframe.
Reason (R): The microbial enzymes necessary to degrade high-molecular-weight PLA are abundant in standard home compost bins and cool soils.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2011

166. Which biopolymer, known as PHB, is specifically a short-chain-length polyhydroxyalkanoate known for its stiffness and brittleness?
(A) Polyhydroxybutyrate
(B) Polyhydroxyvalerate
(C) Polyhexamethylene
(D) Polyhydroxybenzene

2010

167. Which strategy is commonly used to overcome the brittleness and limited barrier properties of standalone biopolymers like starch or PLA?
(A) High-temperature chemical vulcanization of the polymer chains using sulfur
(B) Continuous cryogenic freezing of the biopolymer matrix prior to packaging
(C) Direct exposure and irradiation of the film with high-dose gamma rays
(D) Blending with other polymers, plasticizers, or using multilayer coextrusion

2015

168. What specific property makes thermoplastic starch (TPS) challenging to use as a standalone packaging film for high-moisture foods?
(A) Extreme mechanical hardness and high stiffness that prevents flexible film formation
(B) High hydrophilicity and moisture sensitivity, causing mechanical strength loss
(C) High flammability and rapid thermal degradation when exposed to minor ambient heat
(D) Complete physical impermeability to water vapor that traps gases inside the package

NODIA

2025

169. What is the fundamental difference between an edible film and an edible coating?
(A) Films are chemically synthesized and toxic; coatings are naturally derived and safe
(B) Films are exclusively formulated from lipids; coatings are entirely protein-based
(C) Films are pre-formed solid sheets; coatings are applied as liquids directly on food
(D) There is absolutely no structural, chemical, or physical application difference

2025

170. Which class of edible film materials provides the best barrier against moisture vapor transmission?
(A) Proteins (e.g., casein, whey)
(B) Polysaccharides (e.g., starch, alginate)
(C) Simple sugars (e.g., sucrose)
(D) Lipids (e.g., beeswax, carnauba wax)

2011

171. What is the primary limitation of purely lipid-based edible coatings?
(A) They tend to be opaque, brittle, and can impart a waxy off-taste
(B) They dissolve extremely quickly and too easily in pure water
(C) They exhibit a highly open structure permeable to moisture
(D) They are completely synthetic and cannot be digested by humans

(A) Bulk catering services and large-scale banquets requiring hot holding
(B) Daily food consumption and meal preparation within residential kitchens
(C) On-the-go consumption, military rations (MREs), and outdoor recreation
(D) Long-term frozen food storage applications in commercial deep freezers

2018

138. In a self-cooling can utilizing endothermic dissolution, what occurs when the button is pressed?
(A) A highly pressurized propellant gas expands exothermically into the atmosphere
(B) Calcium oxide is rapidly hydrated with water to release heat into the liquid
(C) A small internal battery powers a thermoelectric Peltier micro-fridge system
(D) Water and a specific salt mix, absorbing thermal energy from the beverage

2019

139. What is a retort pouch?
(A) A flexible laminated pouch that withstands thermal sterilization for shelf stability
(B) A porous synthetic woven bag designed exclusively for boiling fresh vegetables
(C) A rigid coextruded plastic tub engineered for long-term freezing of raw meats
(D) A simple multi-ply paper envelope designed to hold dry beverage powders

2004

140. Which specific property is essential for the innermost polymer layer (e.g., Cast Polypropylene - CPP) of a retort pouch?
(A) High oxygen and moisture permeability to facilitate rapid gas exchange inside
(B) Ability to form a strong, hermetic heat seal that withstands retort temperatures
(C) Complete and total optical transparency to high-energy ultraviolet radiation
(D) High structural stiffness and brittleness at ambient room temperature conditions

2023

141. What is the typical function of the Aluminum foil layer in a 3-ply retort pouch structure (PET/Al/CPP)?
(A) To provide structural bulk and mechanical stiffness to the pouch
(B) To provide an absolute barrier to oxygen, light, and moisture
(C) To act as the primary thermoplastic heat-sealing layer of the pouch
(D) To create a completely transparent optical window for product visibility

2017

142. How does the thermal processing profile of a retort pouch compare to a traditional cylindrical metal can of the same volume?
(A) The pouch processes much faster, leading to higher food quality and less heat damage
(B) The pouch requires a significantly longer thermal processing time to reach sterility
(C) There is absolutely no measurable difference in the total processing time required
(D) The pouch is too thermally sensitive and cannot undergo pressurized retorting at all

2025

143. Which of the following is an outer structural layer commonly used in retort pouches to provide puncture resistance, printability, and strength?
(A) Cast Polypropylene (CPP)
(B) Ethylene Vinyl Acetate (EVA)
(C) Polyethylene Terephthalate (PET)
(D) Paper

2017

144. Identify the INCORRECT statement regarding retort pouch technology.
(A) Retort pouches are lighter and easier to transport than metal cans.
(B) Overpressure in the retort is essential to prevent the pouch from bursting during sterilization.
(C) The high surface-area-to-volume ratio improves heat penetration.
(D) Retort pouches are easily microwavable if they contain an aluminum foil layer.

2022

145. Match the retort pouch laminate layers in List I with their primary functions in List II, and select the correct option.

List I: (Laminate Layers)
P. Outer PET layer
Q. Aluminum foil layer
R. Inner CPP layer
S. Polyurethane adhesive layer

List II: (Primary Functions)
1. Bonds the disparate polymer and metal layers together
2. Provides an absolute gas and light barrier
3. Provides mechanical strength and a printable surface
4. Provides a robust heat seal that survives

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(B) It utilizes complex aesthetic graphical designs to actively attract consumer attention
(C) It requires a continuous, active external electrical power supply to properly function
(D) It incorporates components that release or absorb substances to extend shelf life

2001

181. What is the functional mechanism of an iron-based oxygen scavenger sachet placed inside a food package?
(A) It oxidizes iron powder, irreversibly consuming headspace oxygen
(B) It actively releases gaseous oxygen to maintain fresh food quality
(C) It replaces oxygen with carbon dioxide via enzymatic respiration
(D) It physically blocks atmospheric oxygen from permeating film layers

2014

182. Why are ethylene absorbers particularly important in the active packaging of climacteric fruits (e.g., bananas, avocados)?
(A) Ethylene gas directly causes the internal flesh of the fruit to quickly dry out
(B) Ethylene strongly promotes rapid and highly undesirable lipid oxidation in tissues
(C) Ethylene is a ripening hormone; absorbing it delays decay and over-ripening
(D) Ethylene release causes the surrounding plastic packaging film to weaken and melt

2025

183. Which chemical compound is widely used as an active ingredient in ethylene-absorbing sachets?
(A) Potassium permanganate ($KMnO_4$) on a silica carrier
(B) Highly purified dehydrated sodium chloride crystals
(C) Synthetic ascorbic acid crystals on silica carriers
(D) Fine industrial-grade calcium carbonate powder

2007

184. What role do moisture regulators (desiccants) play in active packaging of dry crispy foods?
(A) They release controlled water vapor to prevent the dry food from becoming too hard
(B) They chemically convert gaseous water vapor into usable respiratory oxygen molecules
(C) They actively regulate and maintain the physical temperature of the packaged food
(D) They absorb headspace moisture to maintain low water activity and crispness

2009

185. Identify the INCORRECT statement regarding antimicrobial active packaging.
(A) Silver nanoparticles (AgNPs) are used for their broad-spectrum antimicrobial activity.
(B) Antimicrobial packaging is designed to completely sterilize heavily contaminated spoiled food.
(C) Antimicrobial agents can be incorporated directly into the polymer matrix.
(D) Essential oils (e.g., thyme, oregano) can be used as natural volatile antimicrobial emitters.

2004

186. Arrange the following events in the function of a moisture-activated volatile antimicrobial emitting package in the correct sequence:
I. Antimicrobial volatiles accumulate in the package headspace.
II. High relative humidity from the food permeates the emitting pad.
III. Volatiles interact with the food surface to inhibit microbial growth.
IV. Moisture triggers the release of the volatile active compound (e.g., chlorine dioxide).
Which of the following represents the correct sequence?
(A) II, IV, I, III
(B) IV, I, II, III
(C) I, II, III, IV
(D) II, I, IV, III

NODIA

2011

187. Which active packaging system is often utilized in fresh poultry packaging to manage excess fluid exudate?
(A) Active oxygen scavengers that consume residual gaseous headspace oxygen
(B) Controlled ethanol emitters that release vapor to inhibit microbial growth
(C) Catalytic ethylene absorbers that scrub plant hormones from the headspace
(D) Moisture-absorbing drip pads that utilize superabsorbent polymers

2019

188. What is the primary application of ethanol emitters in active packaging?
(A) To act as an effective anti-mold agent in high-moisture bakery products
(B) To chemically absorb and neutralize

(A) Overhang greatly improves the physical stability and grip of the pallet during transit
(B) It significantly reduces compression strength, leading to potential load collapse
(C) Overhang substantially increases the overall aesthetic appeal and design of the load
(D) Overhang completely prevents the long-term accumulation of fine dust and moisture

2014

206. Consider the following statements about pallet stabilization:
I. Stretch wrapping is a common method to secure unit loads.
II. Anti-slip sheets can be placed between tiers to increase friction.
III. Strapping is only used for very light loads.
Which of the above statements are correct?
(A) I and II
(B) II and III
(C) I and III
(D) I, II and III

2015

207. In logistics, what does the term "cube utilization" refer to?
(A) The efficiency with which available three-dimensional transport space is filled
(B) The exact thermodynamic number of ice cubes required to chill a shipping container
(C) The specific mathematical geometric shape and structural volume of primary packages
(D) The biological rate at which modular square corrugated cartons naturally biodegrade

2002

208. Which pallet material is generally mandated for international export to prevent the spread of pests (under ISPM 15)?
(A) Untreated raw wood sourced from native forests without any processing
(B) Solid high-grade stainless steel alloys designed for heavy duty use
(C) Heat-treated or fumigated wood, plastic, or synthetic slip sheets
(D) Double-wall corrugated paperboard materials used for lightweight cargo

2011

209. How does an interlocking stacking pattern compare to a columnar (block) stacking pattern regarding structural integrity?
(A) Interlocking provides zero structural stability and causes the entire stack to collapse rapidly
(B) Interlocking significantly increases the vertical compressive strength by more than 100% overall
(C) There is absolutely no structural, physical, or mechanical difference between the two patterns
(D) Interlocking increases lateral stability but can reduce compressive strength by up to 50%

2019

210. In food packaging safety standards, what does Overall Migration Limit (OML) specify?
(A) The maximum permitted quantity of a specific single chemical compound migrating into food
(B) The minimum physical distance a secondary package must safely travel during distribution cycles
(C) The maximum total mass of all non-volatile substances migrating into food or simulants
(D) The total cumulative volume of atmospheric oxygen gas permeating through the plastic film

2015

211. Which liquid is standardly used as a food simulant to test migration for fatty foods?
(A) Aqueous solution of 10% ethanol
(B) Rectified olive oil or synthetic triglycerides
(C) Aqueous solution of 3% acetic acid
(D) Purified deionized distilled water

2008

212. What is a Specific Migration Limit (SML) primarily concerned with?
(A) The total cumulative mass of completely inert and non-toxic substances transferred to the food
(B) The physical migration rate of water molecules out of the package into the external environment
(C) The maximum mechanical processing speed of the high-speed filling and packaging machinery
(D) The migration of individual toxic substances to ensure they remain below safe thresholds

2002

213. Identify the INCORRECT statement regarding migration testing protocols.
(A) OML testing is always conducted using complex mass spectrometry to identify every chemical.
(B) Migration testing often uses food simulants

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(B) I, III and V
(C) II, IV and V
(D) I, II and III

2006

197. What triggers the visual change in a typical pH-based freshness indicator for fish?
(A) Volatile basic amines from spoilage that raise pH and alter dye color
(B) Direct, prolonged exposure to high-energy ultraviolet radiation and light
(C) A rapid drop in internal storage temperature below the freezing point
(D) The physical release of free moisture and liquid exudates from the fish

2015

198. How does a polymer-based diffusion TTI typically function?
(A) It triggers and emits an audible electronic alarm when a thermal limit is breached
(B) The specialized polymer matrix completely and rapidly dissolves at high temperatures
(C) A dyed indicator liquid diffuses along a porous wick at a temperature-dependent rate
(D) It continuously transmits real-time environmental temperature data to a satellite

2024

199. Why is the activation energy (E_a) of a TTI crucial to its design?
(A) It must match the food's spoilage reaction activation energy to track shelf-life loss
(B) It determines the specific visual color profile the TTI label will display upon abuse
(C) It specifies the exact physical dimension, thickness, and size of the adhesive label
(D) It dictates the absolute chemical toxicity and safety profiles of the indicator ink

2003

200. What is the primary objective of unitization in industrial packaging logistics?
(A) To split bulk manufactured products into individual, single-serve consumer-ready portions
(B) To design highly attractive, visually appealing primary packages for retail shelf display
(C) To mathematically calculate the nutritional facts and chemical profiles of bulk cargo
(D) To assemble items into a standardized load to ease handling and reduce transport costs

2007

201. Which pallet dimension is globally recognized as the standard ISO footprint for optimal use of shipping containers?
(A) 500 mm x 500 mm light-duty square footprint
(B) 800 mm x 1200 mm or 1000 mm x 1200 mm standard footprint
(C) 2000 mm x 2000 mm industrial heavy-duty footprint
(D) 100 mm x 200 mm micro-component transit footprint

2012

202. What is the importance of palletization patterns (e.g., columnar vs. interlocking) in unit load design?
(A) It directly determines the color coding and printing layout of the secondary corrugated boxes
(B) It dictates the absolute shelf-life expiration date and thermal history of the food products
(C) Interlocking improves stability against tipping, while columnar stacking maximizes strength
(D) It is utilized solely for aesthetic design purposes and has absolutely no mechanical function

2014

203. Which logistical concept ensures that secondary cartons efficiently fit onto standard pallets, which in turn fit perfectly into standard shipping containers?
(A) Advanced active food packaging systems
(B) Sterile aseptic thermodynamic processing
(C) Modified atmosphere headspace packaging
(D) Modular packaging or dimensional coordination

2016

204. Identify the INCORRECT statement regarding ISO containerization.
(A) Standard ISO dry containers provide hermetic sealing for modified atmosphere transport.
(B) Twenty-foot Equivalent Units (TEUs) are standard units of measurement for container capacity.
(C) ISO containers enable intermodal transport without handling the internal freight.
(D) Reefer containers are utilized for transporting temperature-sensitive food products.

2018

205. What defect occurs when cartons overhang the edge of a pallet during logistics?

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2023

154. Why are conventional aluminum foil trays problematic in standard household microwave ovens if not explicitly designed for them?
(A) They absorb high-frequency microwaves rapidly and melt down into the food structure
(B) They are completely and entirely transparent to microwaves, offering no barrier at all
(C) They release highly toxic chlorinated gases into the oven cavity when heated directly
(D) They reflect microwaves, causing arcing near oven walls and preventing food heating

2003

155. Consider the following statements about microwavable packaging:
I. Susceptors are typically used for products like microwave popcorn and pizzas.
II. Polypropylene containers can distort if the food contains high sugar or fat, which heats beyond the polymer's melting point.
III. Shielding patterns are often printed using non-conductive inks.
IV. Microwaves interact primarily with the polar water molecules in the food.
Which of the above statements are correct?
(A) I, II and IV
(B) II, III and IV
(C) I, III and IV
(D) I, II and III

2022

156. What geometric package design feature helps promote uniform microwave heating of liquid foods?
(A) Sharp rectangular corners that concentrate electromagnetic field lines
(B) Cylindrical or round shapes that prevent localized corner overheating
(C) Extremely shallow and wide flat trays to maximize exposed surface area
(D) Highly thick, uneven bottom surfaces to distribute thermal mass slowly

2023

157. Which component is crucial in a microwavable steam bag (used for vegetables) to ensure safe cooking?
(A) A high-performance susceptor pad to crisp the vegetable surfaces
(B) A self-venting mechanism or valve to prevent explosive steam rupture
(C) A heavily metallized shielding layer to block microwave penetration
(D) A chemical layer of active calcium oxide to generate thermal energy

2015

158. The phenomenon where the edges of a square microwavable meal cook significantly faster than the center is known as:
(A) Edge-heating or corner concentration effect
(B) Localized susceptor activation processes
(C) Electrical arcing and discharge pathways
(D) Internal thermal cold spotting phenomena

2007

159. What defines a biopolymer in the context of food packaging?
(A) Any conventional synthetic plastic utilized to package living biological organisms
(B) Petroleum-derived polymers engineered to be highly resistant to biological degradation
(C) Polymers derived from renewable biological sources and/or those that are biodegradable
(D) Polymeric structures containing active synthetic biocides to prevent mold growth

NODIA

2012

160. Which biopolymer is synthesized through the ring-opening polymerization of a monomer derived from fermented plant starch (like corn)?
(A) Polyhydroxyalkanoate (PHA)
(B) Cellulose acetate
(C) Chitosan
(D) Polylactic Acid (PLA)

2003

161. How are Polyhydroxyalkanoates (PHAs) primarily synthesized?
(A) Through direct chemical synthesis of long-chain petroleum derivatives
(B) By mechanical cross-linking of natural latex harvested from rubber trees
(C) By intracellular bacterial fermentation as energy storage under stress
(D) By thermal extraction of structural collagen fibers from bovine bones

2015

162. Which of the following represents a significant limitation of standard PLA films compared to synthetic PET in beverage packaging?
(A) PLA exhibits complete opacity, which blocks consumer product visibility
(B) PLA has a low glass transition temperature, making it unfit for hot-fill
(C) PLA exhibits extremely high oxygen barriers that prevent natural aging
(D) PLA is chemically unstable and highly toxic when in contact with liquids

rather than real food to simplify analytical quantification.
(C) Tests are typically conducted under worst-case time and temperature conditions reflective of actual use.
(D) 3% Acetic acid is commonly used as a simulant for acidic foods.

2019
214. How is the OML conventionally expressed in analytical testing results?
(A) Milligrams of chemical substance per kilogram of consumer body weight (mg/kg) per day
(B) Mass percentage of the original empty packaging weight that undergoes degradation over time
(C) Milligrams of residue per square decimeter of surface (mg/dm²) or per kg of simulant
(D) Total chemical concentration of the compound expressed in moles per liter (mol/L) of solution

2012
215. Which factor generally increases the rate of chemical migration from a polymer into food?
(A) Increasing storage temperature and contact time
(B) Decreasing the average ambient storage temperature
(C) Substantially increasing the polymer layer thickness
(D) Utilizing a highly inert and high-barrier glass layer

2012
216. Consider the following statements about migration testing:
I. SML values are established based on the toxicological profile (e.g., Tolerable Daily Intake) of the specific substance.
II. Migration is generally higher into dry, solid foods compared to liquid, fatty foods.
III. High temperatures accelerate the diffusion coefficient of migrants in the polymer matrix.
IV. Food simulants are chosen based on the physicochemical properties (hydrophilic/lipophilic/acidic) of the actual food.
Which of the above statements are correct?
(A) I, II and IV
(B) I, III and IV
(C) II, III and IV
(D) I, II and III

2002
217. Why is extraction testing sometimes performed instead of migration testing?
(A) It accurately determines and monitors the commercial shelf life of the packaged food
(B) It finds the total substance present to assume a worst-case 100% migration scenario
(C) It measures the mechanical tensile strength and ultimate elasticity of the polymer film
(D) It is used exclusively to test and verify the barcode readability of printed surfaces

2004
218. Which chemical hazard is notoriously associated with the migration from certain polycarbonate plastics and epoxy resin linings of metal cans?
(A) Phthalates
(B) Styrene monomer
(C) Bisphenol-A (BPA)
(D) Polyvinylidene chloride

2007
219. What is the primary toxicological concern associated with Bisphenol-A (BPA) migration into food?
(A) It acts as a highly corrosive strong mineral acid that dissolves the gut
(B) It causes immediate, highly acute and life-threatening food poisoning cases
(C) It completely and irreversibly destroys all essential vitamins in the food
(D) It acts as an endocrine disruptor, potentially mimicking natural estrogen

2013
220. Where are phthalates primarily used, creating a risk of migration into fatty foods?
(A) As plasticizers added to PVC to provide flexibility
(B) As chemical colorants and pigments in glass bottles
(C) As reaction catalysts during commercial PET synthesis
(D) As active UV light blocking agents in aluminum foil

2010
221. Identify the correct statement regarding chemical hazards in packaging.
(A) Heavy metals like lead and cadmium are widely permitted in high concentrations in modern commercial packaging
(B) Styrene monomer can migrate from polystyrene into hot drinks, causing safety and off-flavor issues
(C) BPA is considered an essential micro-nutrient

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humidity conditions. It evaluates how effectively a polymer or laminate protects dry foods from moisture gain or wet foods from desiccation.

42. (B) Temperature and relative humidity
Both temperature and relative humidity strongly affect the gas transmission rates of polymer films. Elevated temperatures increase molecular mobility, accelerating oxygen diffusion. High relative humidity can swell hydrophilic barrier polymers, such as ethylene vinyl alcohol, opening up the molecular structure and significantly increasing their oxygen transmission rates during storage.

43. (B) High-Density Polyethylene (HDPE)
High-density polyethylene possesses a highly crystalline and linear structure that restricts the movement of water molecules. This high crystallinity gives it an exceptionally low water vapor transmission rate, making it an excellent moisture barrier. It performs far better in blocking moisture than hydrophilic films like nylon or cellulose acetate polymers.

44. (A) OTR measurements are independent of partial pressure gradients.
Gas permeation is driven by concentration and partial pressure differences across a film. Oxygen transmission rate measurements depend directly on the oxygen partial pressure gradient between both sides of the barrier material. Expressing rates without reference to these driving forces is incorrect, whereas thickness-normalized permeability coefficients remain scientifically constant.

45. (A) I, II and IV
Oxygen transmission rate measures gas volume passing through a specific area, and aluminum foil is an absolute barrier when free of pinholes. Additionally, testing water vapor transmission rate requires establishing a constant humidity gradient. Hydrophilic polymers, however, perform poorly under high humidity, making the third statement about barrier properties incorrect.

46. (D) Monitoring weight changes of a desiccant inside a sealed test dish
The gravimetric cup method is a classic technique where a desiccant is placed inside a test dish, which is then sealed with the barrier film. This assembly is placed in a high-humidity chamber, and the water vapor transmission rate is calculated by measuring the weight increase as moisture permeates into the cup.

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47. (C) Coulometric sensor method
The coulometric sensor method is the standard instrumental technique used to measure oxygen transmission rates. In this setup, oxygen gas is passed over one side of the film, while an inert carrier gas sweeps the permeated oxygen from the other side into a highly sensitive electrochemical sensor that generates a precise electrical current.

48. (B) Low OTR
Fatty foods are highly susceptible to rancidity caused by oxygen reacting with double bonds in lipids. To protect these products from oxidative deterioration, off-flavors, and vitamin loss, the packaging material must feature an exceptionally low oxygen transmission rate, ensuring that very little oxygen can enter the package during its shelf life.

49. (D) It decreases the transmission rate.
According to Fick's first law of diffusion, the transmission rate of a gas through a homogeneous polymer is inversely proportional to its thickness. Doubling the thickness of a film doubles the distance the permeating molecules must travel, which cuts the absolute water vapor or oxygen transmission rate in half under constant conditions.

50. (A) LDPE / EVOH / LDPE
Ethylene vinyl alcohol is an outstanding oxygen barrier, but it is highly sensitive to moisture. By sandwiching this polymer between two layers of low-density polyethylene, which is an excellent moisture barrier, the inner core is protected from water. This co-extruded structure provides a highly effective barrier against both oxygen and moisture.

51. (C) By their thermoplastic nature of melting when heated and setting when cooled
Hot-melt adhesives are thermoplastic polymer formulations that are applied in a molten state. They achieve rapid bonding purely through physical cooling and solidification upon contact with cold substrates. This fast-setting behavior does not rely on water or organic solvent evaporation, nor does it require any chemical cross-linking reactions to set.

tensile strength and compression limit of the package

(D) It measures the absolute transmission rate of harmful ultraviolet light through polymer films

2003

230. Why does the sorption of food components (like essential oils or fats) into a polymer sometimes negatively impact the package's integrity?

(A) Sorbed molecules act as plasticizers, causing swelling, loss of barriers, and weak seals

(B) It significantly increases the overall physical mass, making the package too heavy to transport

(C) It triggers chemical reactions that permanently freeze and crystallize the polymer structure

(D) It leads to highly volatile chemical reactions that cause immediate spontaneous combustion

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chemical interaction with acidic foods during storage.

21. (D) Polyethylene Terephthalate (PET)
Polyethylene Terephthalate is a semi-crystalline polyester renowned for its high optical clarity, excellent tensile strength, and good gas barrier properties. It effectively retains carbon dioxide while blocking external oxygen, making it the premier choice for manufacturing carbonated beverage bottles, water bottles, and clear thermoformed food jars.

22. (B) Migration of unreacted monomer and added phthalate plasticizers
Polyvinyl chloride is rigid by nature and requires plasticizers like phthalates to become flexible. The primary food safety concern with this polymer is the potential migration of these toxic plasticizers and residual vinyl chloride monomer into fatty foods, which is heavily regulated to prevent adverse health risks.

23. (C) HDPE possesses a highly linear structure with minimal branch chains.
High-density polyethylene is synthesized under conditions that create a highly linear molecular structure with minimal side-chain branching. This linear configuration allows the polymer chains to pack tightly together, increasing crystallinity, density, rigidity, and moisture barrier properties compared to the highly branched structure of low-density polyethylene.

24. (D) Polypropylene (PP)
Polypropylene has a relatively high melting point of around one hundred and sixty degrees Celsius. This elevated thermal resistance allows containers to withstand hot-fill packaging temperatures and autoclaving without melting, warping, or losing structural shape, making it far superior to low-density polyethylene, polystyrene, or polyvinyl chloride in heat-intensive applications.

25. (B) P-3, Q-4, R-2, S-1
Low-density polyethylene is standard for heat-sealable films, while polystyrene is preferred for thermoforming rigid yogurt cups. Polyamides provide the puncture resistance and oxygen barrier required in vacuum packaging for meats. Polyethylene terephthalate is the primary choice for transparent rigid beverage bottles, establishing a clear link between material properties and applications.

26. (B) Its high capability for thermoforming and physical expansion
Polystyrene is an amorphous polymer that is easy to thermoform into rigid shapes like yogurt cups, and can be physically expanded into lightweight protective foams. It has poor gas barrier properties and low resistance to organic solvents, but its processing versatility and affordability make it ideal for rigid dairy containers.

27. (B) Polyamide - Excellent moisture vapor barrier
Polyamides, commonly known as nylons, contain polar amide groups that absorb water. This hydrophilic nature makes them poor barriers to moisture vapor, despite their outstanding resistance to oxygen gas and physical punctures. Low-density polyethylene, meanwhile, excels at heat sealing, while polyethylene terephthalate provides high structural strength.

28. (A) To provide puncture resistance and an oxygen barrier
Polyamides possess high mechanical strength, toughness, and abrasion resistance, making them excellent at preventing sharp food particles from puncturing packaging. When dry, they also function as highly effective gas barriers. Integrating nylon into co-extruded multilayer films enhances durability and prevents oxygen ingress, protecting perishable vacuum-packed foods.

29. (C) Polyvinyl Chloride
Polyvinyl chloride is generally avoided in direct, non-aqueous food contact unless formulated without plasticizers. The flexible versions of this polymer often rely on heavy additions of plasticizing chemicals, which can easily migrate into high-fat or high-protein food matrices. This migration raises health concerns, making polyethylene and polypropylene safer alternatives.

30. (D) Compliance with strict specific and overall toxicological migration limits
Food-grade status is defined by a plastic material's safety profile during use. Polymers must comply with strict legal limits regulating the chemical migration of monomers, catalysts, and additives into food simulants. Achieving this compliance ensures that packaging does not alter food composition or pose toxic hazards to human health.

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packaging achieves this by consolidating diverse products onto pallets with stretch wraps and strapping. This enables efficient mechanical handling with forklifts, simplifies warehouse logistics, and maximizes transport efficiency rather than focusing on barrier performance or retail aesthetics.

11. (B) High inertness and absolute barrier properties
Glass remains a classic choice for liquid dairy items due to its exceptional chemical inertness and absolute impermeability. It does not interact with food components or allow oxygen, water vapor, or odors to pass through. This outstanding barrier performance keeps dairy products fresh and free from off-flavors, despite its fragility.

12. (A) To prevent chemical corrosion of underlying steel
Tinplate consists of a low-carbon steel sheet coated with a thin layer of pure tin. Steel provides the necessary structural strength and rigidity, while the tin coating serves as a protective barrier. This coating prevents acidic or moist food contents from corroding the steel, avoiding metallic contamination and product spoilage.

13. (C) It has low structural strength without internal pressure or ribbing
Aluminum is lightweight and highly malleable, but it suffers from low structural strength when formed into thin-walled rigid containers. Without pressurized nitrogen inside, or structural ribs on the container body, aluminum cans can easily buckle under load. This limitation must be managed during transport, despite its excellent barrier properties.

14. (D) Kraft process
The Kraft process is the chemical pulping method widely used to convert wood chips into strong, high-yield paperboard. It utilizes sodium hydroxide and sodium sulfide to dissolve lignin, leaving behind strong cellulose fibers. This structural integrity makes the resulting paperboard highly suitable for heavy-duty food and dairy packaging applications.

15. (C) A is true but R is false.
Glass containers have declined in large-scale dairy distribution because they are heavy, fragile, and costly to transport. However, glass is highly unreactive and inert with food products, meaning it does not cause chemical off-flavors. The assertion about its reduced usage is true, but the reason alleging high chemical reactivity is false.

16. (B) Paper is inherently a strong barrier to water vapor and oxygen.
Untreated paper consists of a porous network of cellulose fibers, which offers very poor resistance to moisture vapor and gaseous transmission. To serve as a functional barrier in food packaging, paper must be laminated or coated with plastics or aluminum foil. Other traditional materials like tinplate, aluminum, and glass possess excellent barriers.

17. (D) Aluminum foil
Aluminum foil is integrated into multi-layered aseptic cartons because it provides an outstanding, absolute barrier to light, oxygen, moisture, and odors, even in very thin layers. It prevents photochemical reactions and lipid oxidation, ensuring the long-term shelf stability of UHT-treated milk and juices without the need for refrigeration.

18. (A) Lamination with polyethylene
Paper is highly hydrophilic and loses strength when wet. Laminating paperboard with a layer of low-density polyethylene creates an effective barrier that prevents water absorption, maintaining the box's structural integrity. This polymer lamination is essential for milk cartons and other liquid food packaging that require wet-strength performance.

19. (C) Lower cost due to use of chromium/ chromium oxide coating
Tin-free steel utilizes an ultra-thin layer of chromium and chromium oxide instead of expensive tin. This substitution significantly lowers material costs while still providing decent corrosion resistance and lacquer adhesion. Tin-free steel cannot be soldered easily and requires organic lacquers, but its economic advantage makes it highly popular for cans.

20. (A) It is highly malleable and formed into seamless containers
Aluminum exhibits excellent ductility and malleability, allowing it to be easily drawn and ironed into seamless, lightweight cans or rolled into ultra-thin foils. It is non-magnetic, does not degrade naturally in weeks, and typically requires an internal protective lacquer to prevent

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ANSWERS

1. (D) To protect the product directly and provide immediate containment
Primary packaging is the innermost layer of containment that directly touches the food matrix. Its main purpose is to maintain safety, prevent leakage, and block contaminants from reaching the food. This first-line defense ensures structural containment and shelf-life stability, shielding the product from chemical, biological, and physical hazards from the moment of packaging until consumption.

2. (A) It is the layer in direct contact with the food matrix
Secondary packaging does not touch food directly. It functions as an outer layer to group primary packages together for easier handling, retail display, and transit protection. While primary packaging handles direct containment, secondary systems provide structural reinforcement, damage prevention, and branding space without coming into contact with the food itself.

3. (C) Stretch wrap, pallets, and plastic strapping
Tertiary packaging focuses on bulk handling, unitization, and transport protection. Pallets, stretch wraps, and heavy-duty plastic strappings are typical components because they secure multiple secondary loads into a single stable unit. This level of packaging facilitates safe shipping, mechanical forklift handling, and warehouse distribution without being consumer-facing.

4. (A) Primary packaging - Aluminum beverage can
An aluminum beverage can is an excellent example of primary packaging because it directly contains the liquid food and maintains immediate physical contact. In contrast, pallets represent tertiary packaging, cartons are primary or secondary, and shipping boxes are tertiary structures. Identifying correct packaging levels depends entirely on assessing direct food contact.

5. (A) I and II
Primary packaging acts as the direct containment layer for food, whereas secondary packaging serves to group several primary units together for transport and display. Tertiary packaging is designed specifically for bulk transport, warehousing, and logistics, rather than retail consumer display, making only the first two statements accurate.

6. (B) Secondary packaging
Grouping several individual primary items, like twenty-four beverage cans, into a single unitized display box is the main role of secondary packaging. This layer facilitates retail handling, displays products clearly on supermarket shelves, and offers physical protection to the primary containers, bridging the gap between primary containment and tertiary logistics.

7. (C) Vibration and shock during distribution
Tertiary packaging, such as pallets and stretch wraps, is designed to withstand the physical forces of logistics. In the dairy supply chain, physical damage mostly stems from mechanical vibrations, drop shocks, and movement during vehicular transit. This outermost packaging level absorbs these mechanical energies, preventing damage to internal products.

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8. (D) It improves retail shelf stocking and product brand visibility
Well-designed secondary packaging excels at grouping items to optimize retail shelf space and improve brand presentation. It does not interact with the modified atmosphere, prevent chemical flavor scalping, or replace pasteurization. Instead, it simplifies bulk unpacking, protects individual units, and catches consumer attention with high-quality printing.

9. (A) Tertiary packaging
Tertiary packaging does not come into contact with the food product itself. Because it is used only for bulk transport, unitization, and external protection, it has the lowest risk of chemical migration. Consequently, it is much less likely to require the strict, food-grade safety certifications mandated for primary materials.

10. (B) To consolidate unit loads for logistical handling
Unitization is the process of grouping multiple packages into one large, cohesive load. Tertiary

31. (C) Tensile strength test
The tensile strength test evaluates the maximum mechanical stress a packaging material can withstand under tension before fracturing. By pulling a sample from both ends at a controlled rate, this test measures structural integrity, load-bearing capability, and ultimate elongation. It is a fundamental method for evaluating flexible polymer films and papers.

32. (B) Capacity to withstand internal hydrostatic pressure
The burst strength test, often utilizing the hydraulic Mullen tester, measures the maximum pressure a flat paperboard sheet can support before rupturing. This test evaluates the material's resistance to physical stresses encountered when containers are stacked, dropped, or subjected to internal expansion, reflecting overall mechanical durability and transport safety.

33. (D) Young's modulus
Young's modulus is calculated from the initial elastic region of the tensile force-deformation curve. This value indicates the material's relative stiffness, showing how much a polymer film will deform under a specific mechanical load. High values represent stiff, rigid materials, whereas low values indicate soft, flexible, and easily stretchable polymers.

34. (A) It evaluates the force required to propagate a pre-initiated tear
Tear resistance measures the mechanical force needed to extend an existing slit or notch in a packaging film. It is distinct from puncture or burst testing, and is typically measured using specialized equipment like the Elmendorf pendulum tester. This property determines how easily a package can be opened or torn during handling.

35. (A) II, IV, I, III
To perform a standard tensile test, the operator must first cut the polymer film into a precise geometric shape. Next, the specimen is pre-conditioned at a set temperature and relative humidity. It is then securely clamped into the machine's grips, and finally, tension is applied to record the force-elongation curve.

NODIA

36. (A) Puncture evaluates resistance to probe penetration; tear measures slit propagation.
Puncture testing measures a film's ability to resist penetration by a sharp or blunt probe, simulating the impact of sharp objects like bones. Tear testing, conversely, measures the energy required to propagate a pre-cut slit across the material. Both tests assess distinct failure mechanisms under different physical conditions.

37. (D) Kilopascals (kPa)
Burst strength is a measure of pressure resistance and is most commonly expressed in kilopascals or pounds per square inch. This unit reflects the hydraulic force per unit area applied to a circular specimen before it ruptures, making it a key parameter in certifying the quality of corrugated shipping boxes.

38. (B) Soft and highly stretchable
A polymer film with low tensile strength but exceptionally high elongation at break is characterized as soft, flexible, and highly ductile. It cannot support heavy structural loads, but it can stretch significantly before fracturing. This behavior is typical of low-density polyethylene films used for stretch wrapping products.

39. (C) Elmendorf tear tester
The Elmendorf tear tester is the standard instrument used to determine the tear resistance of paper, paperboard, and plastic films. It utilizes a weighted pendulum to measure the energy required to propagate a pre-cut slit through a set distance, providing highly reproducible data for industrial material quality control.

40. (D) To prevent sharp bone-in cuts from piercing the packaging during transit
Vacuum packaging draws plastic films tight against the product surface. For bone-in meats, sharp protrusions can easily pierce weak films, causing a loss of vacuum and rapid microbial spoilage. Measuring and optimizing puncture resistance ensures that the packaging material can withstand these localized forces throughout the entire distribution chain.

41. (A) The mass of water vapor passing through a unit area per unit time
Water Vapor Transmission Rate is a critical barrier metric that quantifies the mass of moisture passing through a flat packaging material of a specific area under controlled temperature and

62. (D) To show energy values and standardized nutrient contents per typical serving
The nutritional fact panel provides consumers with standardized information about the energy value and nutrient profile of a food product. It lists key components such as proteins, carbohydrates, fats, sodium, and specific vitamins per serving or per one hundred grams, enabling healthy dietary choices and objective comparison between different products.

63. (C) Rotogravure
Rotogravure is an industrial printing process that uses engraved copper cylinders to transfer low-viscosity inks onto packaging films. It is highly favored for long-run flexible food packaging due to its exceptional image reproduction, high printing speed, and consistent quality over millions of impressions, despite high initial cylinder costs.

64. (B) Net quantity can be declared in non-standard units if chosen by manufacturers.
Under Indian packaging regulations, the declaration of net quantity must strictly utilize standardized metric units, such as grams, kilograms, milliliters, or liters. Using non-standard units is prohibited. Other rules, such as displaying vegetarian symbols, manufacturing dates, and detailed nutritional facts, remain completely mandatory on the principal display panel.

65. (A) P-2, Q-3, R-1, S-4
Flexography uses flexible relief plates for printing, while the principal display panel is the primary section seen by shoppers. Nutritional claims highlight specific dietary properties like fat levels, and batch codes provide unique alphanumeric tracking. Linking these terms with their correct definitions is essential for compliant and lawful packaging design.

66. (A) By functional class with specific names or standard INS codes
FSSAI mandates that food additives be declared on the label by their functional class followed by their specific chemical name or standard international numbering system code. This standardized declaration format provides clear information to consumers about why an additive is used and its exact identity, without compromising proprietary recipes.

67. (C) The Radura logo with a specific written declaration
Food products treated with ionizing radiation must feature the international Radura symbol on their packaging. FSSAI regulations dictate that this green logo must be accompanied by a clear, written statement such as "treated with radiation" or "irradiated," ensuring consumers are fully informed about the processing technology used on the food.

68. (A) It uses liquid inks and flexible photopolymer plates for plastic substrates.
Flexography is a widely used rotary printing process that employs flexible photopolymer relief plates and fast-drying liquid inks. This setup allows it to print efficiently on a wide variety of substrates, including flexible plastic films, paper, and corrugated board, making it highly versatile and cost-effective for modern food packaging.

69. (D) They must feature low chemical migration potential to prevent contamination.
Inks used on the outside of food packaging must be formulated to minimize the migration of hazardous chemicals into the food. Since compounds can migrate through packaging layers or during stack storage, low-migration inks are essential to prevent chemical food contamination, off-flavors, and health risks to the end consumers.

70. (B) 1D codes store data in linear lines; 2D codes use a grid of square modules.
One-dimensional barcodes encode data horizontally using variations in the width and spacing of parallel black lines. Two-dimensional codes, such as QR codes, encode information both horizontally and vertically within a grid of square modules. This two-dimensional structure allows them to store significantly more data in a much smaller area.

71. (C) 2D QR Code
A two-dimensional QR code has a vastly superior data capacity compared to traditional linear barcodes. It can easily store thousands of alphanumeric characters, allowing manufacturers to encode website URLs, digital allergen warnings, detailed batch tracing histories, and promotional media directly on the retail packaging for consumer use.

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52. (A) Solventless or water-based polyurethane systems
Flexible food packaging lamination increasingly utilizes solventless or water-based polyurethane adhesives. These modern formulations do not emit volatile organic compounds or leave behind hazardous solvent residues, making them safer for plant operators and significantly reducing the risk of chemical migration and off-flavors in packaged food products.

53. (D) Evaporation or absorption of water from the liquid carrier system
Water-based adhesives consist of active polymers dissolved or dispersed in water. When applied, they form a strong bond as the water carrier evaporates into the air or absorbs into porous substrates like paper. This physical drying process consolidates the adhesive layer, locking the two surfaces together without requiring thermal melting.

54. (B) They require heating systems to dry out solvents before laminate bonding.
Solvent-based adhesives contain polymers dissolved in volatile organic solvents. During lamination, the adhesive is applied as a liquid, and the web must pass through heated drying tunnels to evaporate all solvents before bonding. This step is crucial to prevent solvent entrapment and ensure a strong, odor-free laminated structure for foods.

55. (C) A is true but R is false.
Hot-melt adhesives are highly favored for fast corrugated carton lines because they set almost instantly upon cooling, requiring no drying time. This rapid physical setting matches high-speed manufacturing demands. The assertion is true, but the reason is false, as these systems contain no water or solvents that need to evaporate.

56. (D) The water cannot easily escape non-porous films, slowing drying times.
When water-based adhesives are applied between two non-porous polymer films, the water molecules cannot penetrate the plastic substrates. Because the water is trapped, evaporation is severely restricted, leading to extremely slow drying times and weak bonds. This limitation makes solvent-based or solventless systems more suitable for plastic film lamination.

57. (A) Tackifying resins
Hot-melt adhesive formulations rely on tackifying resins to provide immediate wet grab and surface wetting properties when molten. These resins are blended with base polymers, which provide cohesive strength, and wax components, which control the viscosity and setting speed, resulting in a balanced adhesive system for fast-moving packaging lines.

58. (B) The initial bonding strength prior to full drying or curing
Green tack refers to the immediate adhesive hold and bonding strength developed right after contact, before the adhesive has fully dried, cooled, or chemically cured. High green tack is essential in packaging operations to keep box flaps held down securely while passing through fast-moving folder-gluer production lines.

59. (B) To avoid toxic solvent migration into food which causes off-flavors
Restricting residual solvent levels in flexible laminates is critical for food safety. If volatile solvents are trapped in the adhesive layer, they can migrate through the inner polymer film directly into the food. This chemical migration can create unpleasant off-flavors, ruin sensory quality, and violate strict toxicity standards.

60. (A) Manufacturing of corrugated paperboard structures
Starch-based adhesives are water-soluble natural polymers used extensively in manufacturing corrugated paperboard. When applied to fluted paper, the starch slurry absorbs into the porous paper fibers and gelatinizes when heated, forming a cheap, strong, and highly stable bond that holds the liners and flutes together securely during logistics.

61. (C) The list of food ingredients ordered descending by weight or volume
FSSAI regulations mandate that packaged foods display a clear ingredient list on the label. This list must arrange all raw materials, additives, and water in descending order of their incoming weight or volume at the time of manufacture. This requirement ensures complete consumer transparency and assists in identifying potential allergens.

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that is intentionally added to packaging to fortify foods
(D) Migration kinetics are entirely and completely independent of the chemical composition of the food matrix

2002
222. Which migration kinetic model best describes the movement of a plasticizer from a PVC film into a high-fat cheese?
(A) Zero-order kinetic processes independent of reactant concentration and temperature
(B) Fickian diffusion driven by concentration gradients and partition coefficients
(C) First-order nuclear radioactive decay kinetics of unstable isotopic compounds
(D) Thermodynamic Newton's law of convective cooling across the film boundary

2004
223. What regulatory shift has occurred globally in response to BPA migration concerns?
(A) Transitioning to BPA-free alternatives like BPS or polyester-based can coatings
(B) Legally mandating significantly increased use of BPA compounds in baby bottles
(C) Completely banning the manufacture and use of all metal food cans entirely
(D) Broadly recommending boiling all plastic packaging containers prior to use

2024
224. How do printing inks applied to the outside of a package pose a migration hazard to the food inside?
(A) Because printing inks continuously emit highly penetrating and harmful gamma radiation.
(B) Because solvent-based inks completely dissolve the intermediate plastic layers of film.
(C) Through set-off on rolls, where the printed outer surface contacts the inner layer.
(D) Because organic inks rapidly turn into toxic heavy metals when exposed to ambient light.

2006
225. In the context of mass transfer phenomena, what is "flavor scalping"?
(A) The physical and mechanical removal of the outer skin or peel layer of a fresh fruit
(B) The continuous and direct migration of a synthetic plastic taste into the food matrix
(C) The deliberate addition of active artificial flavors to the thermoplastic packaging film
(D) Sorption of volatile flavor compounds from food into the polymer, causing aroma loss

2016
226. Consider the following statements about mass transfer phenomena:
I. Flavor scalping is prevalent when lipophilic flavor compounds interact with lipophilic polymers like PE or PP.
II. Migration is the transfer of substances from the food into the packaging.
III. Permeation involves mass transfer of gases or vapors completely through the packaging wall.
IV. Sorption can alter the mechanical and barrier properties of the polymer.
V. Glass packaging exhibits significant flavor scalping.
Which of the above statements are correct?
(A) I, II, III
(B) I, III, IV
(C) II, IV, V
(D) I, III, V

2012
227. Which type of food product is most susceptible to significant quality degradation due to flavor scalping?
(A) Dehydrated rolled oats stored in dry paperboard containers
(B) Citrus juices in LDPE-lined cartons due to d-limonene sorption
(C) Standard iodized table salt packaged in a sealed glass jar
(D) Pure water frozen blocks stored in heavy polyethylene bags

2003
228. What represents the three primary mass transfer phenomena in food-packaging interactions?
(A) Conduction, convection, radiation
(B) Evaporation, condensation, sublimation
(C) Oxidation, reduction, hydrolysis
(D) Migration, permeation, sorption

2002
229. How does the partition coefficient (K_p) apply to food-packaging interaction matrices?
(A) It describes the equilibrium concentration ratio of a migrant between food and packaging
(B) It calculates the dimensional ratio of the thickness of the package to the total food volume
(C) It mathematically determines the ultimate

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72. (D) To print non-contact variable data like expiry dates and lot codes at high speed
Continuous inkjet printers are designed to spray microscopic ink droplets through the air onto moving surfaces. This non-contact technology is ideal for applying variable data, such as manufacturing dates, expiration timelines, and batch codes, onto uneven or delicate packaging materials at very high line speeds during manufacturing.

73. (A) They feature built-in error correction, remaining readable if partially damaged.
Two-dimensional QR codes incorporate Reed-Solomon error correction algorithms. This feature enables scanners to decode the encoded information even if the printed symbol is dirty, torn, or partially obscured by up to thirty percent. This robustness makes them highly reliable for real-world logistical, warehouse, and retail packaging environments.

74. (B) Thermal Transfer Overprinting (TTO)
Thermal transfer overprinting utilizes a heated printhead to melt ink from a thin ribbon directly onto flexible packaging films. This thermal marking technology provides high-resolution, smudge-resistant prints of variable data such as barcodes and expiration dates, making it popular for flow-wrappers and bagging lines in food plants.

75. (A) II, III, IV, I
The scanning of a linear barcode begins as a laser sweeps across the printed pattern. The dark bars absorb the light, while the light spaces reflect it. A photodiode detects these variations in reflected light intensity, and the internal decoder converts the electrical signal into usable digital data representing the product.

76. (A) 13 numeric digits
A standard EAN-13 barcode is designed specifically to encode exactly thirteen numeric digits. This numeric sequence contains a country code, manufacturer code, product code, and a final check digit, allowing point-of-sale systems to look up pricing and manage inventory instantly in retail stores and distribution networks worldwide.

77. (C) It creates permanent, indelible marks without using any consumables.
Laser coding uses a focused light beam to burn, ablate, or color-change the surface of a packaging material. Since this process does not require ink or solvent refills, it reduces operating costs. It also produces sharp, indelible marks that cannot be rubbed off or altered during transport.

78. (D) They act as position targets for high-speed 360-degree reading.
The three distinctive squares located in the corners of a QR code are position detection patterns. They allow scanner cameras to instantly recognize the code's orientation and size, enabling rapid, three-hundred-and-sixty-degree scanning from any angle, even if the package is moving quickly on a conveyor belt during sorting.

79. (C) To enable precise product traceability, recall control, and inventory tracking
Variable data coding is crucial because it applies unique, dynamic information to each package, such as exact production times and batch numbers. This enables tracking along the entire supply chain, allowing rapid, targeted product recalls in the event of contamination, while simplifying inventory rotation and retail stock management.

80. (B) Photodegradation of riboflavin
Exposure to ultraviolet and visible light initiates the rapid photodegradation of riboflavin in milk. As riboflavin absorbs light energy, it acts as a photosensitizer, catalyze the oxidation of lipids and proteins, which leads to off-flavors and nutrient loss. Protecting products from light is critical to maintaining milk quality.

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81. (D) It promotes lipid auto-oxidation which directly yields bad off-flavors
In fat-rich foods like butter, oxygen permeation triggers lipid auto-oxidation. This chemical reaction breaks down unsaturated fatty acids into volatile aldehydes, ketones, and carboxylic acids, which produce strong metallic and rancid off-flavors. Packaging with excellent oxygen barriers is therefore essential to prevent this sensory degradation and preserve shelf life.

82. (A) Arrhenius equation
The Arrhenius equation is widely used to model and predict the temperature dependence of

against gas permeation, light transmission, and moisture migration. By completely blocking oxygen, UV radiation, and water vapor, it prevents chemical oxidation, photo-degradation, and moisture loss, preserving the quality and shelf life of the sterile food inside.

142. (A) The pouch processes much faster, leading to higher food quality and less heat damage
Retort pouches have a much thinner profile and a higher surface-area-to-volume ratio than traditional cylindrical metal cans. This geometric advantage allows thermal energy to penetrate to the thermal center of the product much faster, significantly reducing the required heating time, which minimizes thermal degradation and preserves food flavor, color, and texture.

143. (C) Polyethylene Terephthalate (PET)
Polyethylene terephthalate is commonly selected as the outermost layer of retort pouches because it provides outstanding mechanical strength, dimensional stability, and excellent puncture resistance. Additionally, this polymer offers a highly receptive and smooth surface for high-quality printing, protecting the visual graphics and structural integrity during handling and sterilization in industrial settings.

144. (D) Retort pouches are easily microwavable if they contain an aluminum foil layer.
Retort pouches containing an aluminum foil layer reflect electromagnetic radiation and are not safe for use in microwave ovens, making the claim of easy microwavability incorrect. Conversely, pouches are lightweight, require overriding pressure to prevent thermal bursting during processing, and benefit from high surface-area-to-volume ratios that facilitate rapid thermal energy transfer.

145. (A) P-3, Q-2, R-4, S-1
In retort pouch design, the outer PET layer provides mechanical strength and printing capability, while the aluminum foil acts as an absolute barrier. The cast polypropylene inner layer ensures a robust heat seal that survives processing, and the polyurethane adhesive bonds these disparate layers together, creating a unified laminate that protects food.

146. (B) Maintaining overriding air pressure to prevent pouch rupture as internal steam condenses
During the cooling phase of retort sterilization, steam inside the pouch condenses rapidly, creating a severe pressure differential. To prevent the pouch seals from bursting due to internal pressure exceeding chamber pressure, the system must maintain overriding compressed air pressure. This pressure control balances the forces acting on the flexible structure.

147. (D) They provide product visibility and are completely microwave-safe
Aluminum-free, high-barrier transparent retort pouches, utilizing specialized inorganic coatings like silicon oxide or aluminum oxide on PET, are increasingly popular in modern packaging. These advanced materials allow consumers to see the food product inside clearly while remaining completely safe for use in microwave ovens, combining convenience with outstanding preservation performance over shelf life.

148. (A) Channel leakers or product contamination in the seal zone
Identifying seal defects like channel leakers or product contamination in the seal zone is critical prior to thermal processing. These micro-channels compromise the hermetic seal of the retort pouch, allowing microbial pathogens or air to bypass the barrier, which inevitably leads to post-process contamination, food spoilage, and severe food safety risks.

149. (C) It permits microwaves to pass through with minimal absorption, heating food directly
A microwave-transparent packaging material is characterized by its ability to allow high-frequency electromagnetic waves to pass through it with virtually no physical absorption or reflection. This property ensures that the microwave energy is directed entirely into the polar water molecules of the food product, enabling direct and efficient internal dielectric heating.

150. (A) Polypropylene (PP)
Polypropylene is highly suitable for microwave-transparent rigid containers due to its high heat deflection temperature, which allows it to withstand temperatures exceeding one hundred degrees Celsius without melting or deforming. Its lack of polar molecular groups ensures that it does not absorb microwave energy, allowing efficient, direct heating of the food.

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92. (A) Resonance, which amplifies physical vibrations and causes damage
Resonance occurs when the excitation frequency of a transport vehicle matches the natural frequency of the packaged product. This alignment amplifies physical vibrations, causing high-amplitude movements that can damage fragile components, break glass, or dent cans. Protective packaging must be designed to decouple these frequencies during logistics.

93. (C) Damping materials dissipate kinetic energy, lowering physical amplitude at resonant states.
Damping materials absorb and dissipate vibration energy, reducing the amplitude of movement at resonant frequencies. To protect products, cushioning must be designed so its natural frequency is lower than the transport vibration frequencies. Stiff brackets do not damp vibrations, and transit damage can occur in any commercial distribution chain.

94. (D) Expanded polystyrene (EPS) foam
Expanded polystyrene foam is widely used for transit protection due to its excellent shock-absorbing properties. Its structure of closed, air-filled cells deforms under load, absorbing kinetic energy and cushioning fragile products against multi-directional impacts. This high performance makes it a standard material for shipping delicate fresh food products.

95. (A) Both A and R are true and R is the correct explanation of A.
Drop testing protocols adjust the fall height based on the package's gross weight. Lighter packages are typically lifted and moved manually, making them more susceptible to drops from greater heights. Heavy, palletized loads are handled by forklifts, meaning they experience shorter drops, which justifies the use of different test heights.

96. (B) To define critical velocity and peak acceleration levels products can withstand
A fragility curve, or damage boundary curve, is used in protective packaging design to identify the critical velocity and peak acceleration levels a product can tolerate before breaking. Knowing these limits allows packaging engineers to design cushioning systems that keep transit forces below these critical thresholds, preventing product breakage.

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97. (D) The gradual loss of foam thickness under a constant static weight load
Creep in cushioning materials refers to the gradual loss of foam thickness that occurs under a constant, long-term static weight. This compression over time reduces the foam's ability to absorb shock during transit. Packaging designers must account for creep to ensure materials maintain their protective performance during warehouse storage.

98. (A) By compression of entrapped air cells upon physical impact
Air bubble wraps protect products through the compression of air trapped within small plastic cells. When the package experiences an impact, these air cells compress, absorbing and distributing the kinetic energy. This compression prevents the force of the impact from reaching the product, protecting fragile food items during physical transport.

99. (C) A specific drop sequence of corners, edges, and flat faces
Standard drop testing for rectangular cartons involves a specific sequence of drops on its corners, edges, and flat faces. This approach ensures the package is evaluated from all angles, simulating real-world handling drops. This thorough testing verifies that both the structural joints and the product are protected from impacts.

100. (A) Protection from ultraviolet light and ambient chemical contaminants
Packaging for pasteurized liquid milk must protect the product from light and external contaminants. Light exposure triggers riboflavin degradation and lipid oxidation, leading to off-flavors, while chemical barriers prevent the absorption of ambient odors. Pasteurized milk does not undergo high-temperature retort sterilization, which requires different material property considerations.

101. (D) Material resistance to lactic acid with barriers to prevent desiccation
Fermented dairy products contain active lactic acid, requiring packaging materials that are resistant to acidic breakdown. The packaging must also provide a moisture barrier to prevent desiccation and whey separation. Complete vacuum sealing is not used, as it can crush soft yogurt, and light exposure is kept to a minimum.

food degradation reactions. By calculating the activation energy, this mathematical relationship allows packaging scientists to estimate how shelf life will change when a packaged food product is exposed to fluctuating temperatures during storage and distribution.

83. (C) Powder caking, clumping, and microbial growth
When moisture enters a package containing hygroscopic powders like milk powder, it increases the moisture content. This absorption causes the particles to become sticky, leading to caking, clumping, and a loss of solubility. Elevated moisture levels also raise water activity, creating conditions that support microbial growth and chemical spoilage.

84. (A) Caking of powders - Low Water Vapor Transmission Rate (WVTR)
Powder caking is caused by moisture absorption, which occurs when a packaging material has a high water vapor transmission rate. A low transmission rate actually protects dry powders by keeping moisture out. In contrast, lipid oxidation, vitamin loss from light, and staling from moisture loss are correctly paired with their causes.

85. (B) II and IV
Lipid oxidation kinetics do not remain zero-order indefinitely, as they speed up after the induction period. In addition, oxygen scavengers cannot completely halt anaerobic microbial degradation, as some pathogens thrive without oxygen. Statements regarding riboflavin photodegradation and moisture-induced changes to glass transition temperatures of powders are completely accurate.

86. (B) Opacity or specific UV/visible light block
Protecting riboflavin in pasteurized milk requires packaging with high opacity or specific light-blocking properties. Riboflavin is highly sensitive to light in the blue and ultraviolet spectrum. Restricting these wavelengths prevents photodegradation and the resulting light-activated off-flavors, maintaining the milk's sensory quality, visual appeal, and nutritional value.

87. (C) They serve as catalysts for initiating free radical formation
Transition metal contaminants act as powerful catalysts that accelerate lipid oxidation in foods. They decompose hydroperoxides into highly reactive free radicals, which speeds up the chain reactions that cause rancidity. To prevent this, packaging materials must be free of metallic impurities that can leach into fatty foods.

88. (D) The critical moisture content at which food chemical quality deteriorates
Moisture sorption isotherms show the relationship between food moisture content and water activity at a constant temperature. This information helps packaging engineers identify the critical water activity levels where degradation, such as caking or lipid oxidation, accelerates, allowing them to select materials with the appropriate water barrier properties.

89. (A) Proteins and reducing sugars
The Maillard reaction is a non-enzymatic browning pathway that occurs between the amino groups of proteins and the carbonyl groups of reducing sugars. This reaction is highly dependent on water activity, typically peaking at intermediate levels. Controlling moisture transfer is essential to prevent undesirable color and flavor changes in stored foods.

90. (B) By absorbing kinetic energy and extending deceleration time during impact
Cushioning materials protect packaged foods by absorbing the kinetic energy of physical impacts. When a package drops or collides, the cushion deforms, which extends the deceleration time and reduces the peak shock forces transmitted to the product, keeping the forces below the product's physical fragility threshold during distribution.

91. (B) Drop testing
Drop testing evaluates a package's ability to withstand sudden physical impacts from free-fall drops. This test simulates real-world handling hazards, such as a box falling from a conveyor, shelf, or forklift. It measures the structural integrity of both the packaging material and the food product under severe mechanical deceleration forces.

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significantly extends the shelf life of fresh food products.

113. (D) For packaging fresh red meat to maintain bright oxymyoglobin color
High concentrations of oxygen are used in modified atmosphere packaging for fresh red meat to promote the formation of oxymyoglobin. This pigment gives the meat a bright, cherry-red color that consumers associate with freshness, preventing it from turning into metmyoglobin, which has an unappealing, dull brown color.

114. (A) Equilibrium modified atmosphere packaging is designed for respiring produce, such as fresh fruits and vegetables, rather than non-respiring processed meats.
Equilibrium modified atmosphere packaging is designed for respiring produce, such as fresh fruits and vegetables, rather than non-respiring processed meats. It balances the product's respiration rate with the packaging film's gas permeability. This balance maintains a steady-state gas composition that extends shelf life without triggering harmful anaerobic fermentation.

115. (B) II and III
Carbon dioxide has bacteriostatic and fungistatic properties, and high oxygen levels are used in red meat packaging to maintain color. Nitrogen, however, is not highly soluble in water or fat, meaning it does not cause package shrinkage. Statements II and III are correct, while statement I is completely incorrect.

116. (A) High CO_2 (e.g., 60%) balanced with N_2
Carbon dioxide acts as an effective fungistatic agent that significantly delays mold growth on the surface of fresh bakery products. Balancing this gas with nitrogen prevents the packaging from collapsing due to carbon dioxide dissolution into the food matrix, while simultaneously maintaining a balanced atmosphere that avoids oxidation and off-flavor development during storage.

117. (C) Package collapse due to CO_2 dissolving into the food
High-moisture foods absorb carbon dioxide rapidly because of the high solubility of this gas in water and lipids. When carbon dioxide dissolves into the food matrix, it creates a partial vacuum within the headspace of the package. Without a structural filler gas like nitrogen, this internal pressure drop leads to severe package collapse.

118. (A) Matching film oxygen permeability to the product's respiration rate
Fresh fruits and vegetables continue to respire after harvest, consuming oxygen and producing carbon dioxide. Designing packaging for these commodities requires matching the film permeability with the specific respiration rate of the product. This equilibrium creates an optimal internal atmosphere, preventing anaerobic respiration, off-flavors, physiological disorders, and rapid degradation of the fresh tissue.

119. (D) Development of sour off-flavors from carbonic acid formation
When high concentrations of carbon dioxide dissolve in the aqueous phase of fluid dairy products or high-moisture foods, the gas hydrates to form carbonic acid. This chemical reaction lowers the pH of the system, leading to the development of distinct sour off-flavors and potentially destabilizing proteins within the food matrix over storage.

120. (B) Thermal orientation during manufacture and shape recovery upon heating
Shrink wrapping relies on the thermal orientation of polymer chains during the manufacturing process. The film is stretched under controlled temperatures to orient the molecules and then rapidly cooled to freeze them in this stressed state. Reheating the film allows the chains to release stress and return to their original, random coiled state.

121. (C) Oriented polymer chains release stress and revert to a random coiled state
When a shrink film is exposed to heat in a tunnel, the thermal energy provides the polymer chains with sufficient mobility to overcome the frozen-in stresses from manufacture. The highly oriented polymer chains release this stored energy and revert to a thermodynamically favored, random coiled state, causing the film to contract tightly around the product.

122. (D) Inherent elastic recovery after being mechanically tensioned around a load
Stretch wrapping does not require thermal energy to achieve a tight fit. Instead, it relies on the inherent elastic recovery of the polymer film

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after being mechanically stretched around a unit load. This immediate elastic return force exerts a continuous holding pressure, securing the items together tightly without thermal processing equipment.

123. (A) Linear Low-Density Polyethylene (LLDPE)
Linear Low-Density Polyethylene is the primary polymer of choice for pallet stretch wrapping due to its molecular structure, which features short-chain branching. This architecture provides excellent tensile strength, high elongation, exceptional puncture resistance, and tear propagation resistance. These qualities, combined with inherent or added cling properties, ensure reliable unitization of heavy pallet loads.

124. (B) Shrink wrapping - Tamper-evident neck bands on sauce bottles
Shrink wrapping technology is widely used to apply tamper-evident neck bands on sauce bottles. These pre-formed plastic rings or sleeves are placed loosely around the cap and bottleneck, and then exposed to heat, causing them to shrink tightly to conform to the profile. This serves as a reliable indicator of product integrity.

125. (A) IV, II, I, III
The standard operational sequence for applying shrink wrap starts with feeding the product into the wrapping machine. Next, the film is cut and sealed to form a loose sleeve around the load. This assembly then passes through a heated tunnel where thermal energy triggers contraction, resulting in the film shrinking tightly around the contours.

126. (A) The percentage dimensional reduction of the film under unrestricted heat
The shrink ratio of a film represents the percentage of dimensional reduction that the plastic material undergoes when exposed to unrestricted thermal energy. This physical parameter is measured in both the machine direction and the transverse direction, guiding engineers in selecting the correct film dimensions and heating parameters for specific product profiles.

127. (C) To provide cling so film layers stick to themselves without adhesive
In stretch wrapping applications, the incorporation of tackifiers or specific low-density polymer blends is crucial for creating cling. This property ensures that overlapping layers of film adhere securely to themselves without the need for additional adhesives or heat, maintaining structural integrity and preventing loose tails during transport and handling over storage and transit.

128. (D) It stabilizes the load against shifting and vibration without requiring heat
Stretch wrapping provides outstanding lateral stability to palletized unit loads, preventing shifting and damage caused by transport vibrations. Because this technology relies entirely on mechanical tension and elastic recovery, it achieves robust unitization without requiring heat, which eliminates the energy expenses and safety hazards associated with high-temperature shrink tunnels in logistics operations.

129. (C) Utilizing controlled exothermic chemical reactions
Self-heating packaging systems operate on the principle of harnessing controlled exothermic chemical reactions within a secondary compartment adjacent to the food or beverage. These localized reactions quickly release thermal energy, which transfers conductively through a highly conductive barrier to heat the product to a desirable consumption temperature without external heating equipment.

130. (B) Hydration of quicklime ($CaO + H_2O \rightarrow Ca(OH)_2$)
The hydration of quicklime, where calcium oxide reacts with water to form calcium hydroxide, is the most common chemical reaction utilized in commercial self-heating beverage cans. This reaction is highly exothermic, rapidly releasing substantial thermal energy while generating non-toxic, easily manageable byproducts that pose minimal safety risks to consumers during use.

131. (D) Puncturing an internal barrier to mix water with the CaO
In self-heating cans utilizing calcium oxide, the reaction is kept inactive by keeping the water and the dry calcium oxide in separate compartments. Activating the system requires a mechanical action, such as pressing a button on the base, which punctures an internal barrier to allow the water to mix directly with the quicklime.

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132. (A) Endothermic dissolution of salts or evaporation of compressed liquids
Self-cooling beverage cans operate via endothermic processes, which absorb thermal energy from the product. This cooling is achieved either through the endothermic dissolution of specific salts in water or by utilizing the rapid evaporation of compressed liquid refrigerants. Both mechanisms draw heat away from the beverage, lowering its temperature for immediate consumption.

133. (C) Managing heat transfer to food while preventing burns and conserving space
A major engineering challenge in self-heating packaging involves balancing thermal dynamics to ensure rapid, uniform heat transfer to the food or beverage while protecting consumers from skin burns. Designers must integrate sufficient insulation on the exterior surfaces and optimize the internal compartment volume to avoid excessively reducing the space available for the food itself.

134. (A) The CaO + water reaction is endothermic.
The hydration reaction between calcium oxide and water is highly exothermic, meaning it releases thermal energy rather than absorbing it. Describing this chemical process as endothermic is scientifically incorrect. The active thermal systems require insulation, decrease the usable product volume within standard dimensions, and represent a class of active packaging designed to modify product conditions.

135. (A) Both A and R are true and R is the correct explanation of A.
Self-cooling technologies utilizing the evaporation of compressed refrigerants have faced significant regulatory and environmental challenges because the release of volatile organic compounds or greenhouse gases during activation is harmful. Consequently, both statements are factually correct, and the environmental impact of these emissions directly explains the intensive scrutiny and restrictions placed on such packaging.

136. (B) Because of its high thermal conductivity, which enables rapid heat transfer
Aluminum is highly preferred for the barrier separating the food compartment from the reaction chamber because of its outstanding thermal conductivity. This physical property allows for rapid, efficient heat transfer across the interface, ensuring that the beverage heats or cools quickly while preventing chemical leakage or cross-contamination from the reactive reagents.

137. (C) On-the-go consumption, military rations (MREs), and outdoor recreation
The primary target market for self-heating packaging includes outdoor enthusiasts, military personnel utilizing meal-ready-to-eat rations, and on-the-go consumers who require hot meals or beverages in locations where conventional cooking appliances, electricity, or open fires are unavailable or impractical. These scenarios maximize the utility of portable chemical heating and cooling systems during transit.

138. (D) Water and a specific salt mix, absorbing thermal energy from the beverage
In self-cooling cans based on endothermic dissolution, pressing the activation button breaks an internal seal, allowing liquid water to mix with a solid anhydrous salt. This dissolution process absorbs thermal energy from the surrounding environment, drawing heat directly from the beverage across the metal wall and lowering its temperature rapidly.

139. (A) A flexible laminated pouch that withstands thermal sterilization for shelf stability
A retort pouch is a specialized flexible packaging structure constructed from multiple laminated plastic and metallic layers designed to withstand the high temperatures and pressures of commercial thermal sterilization. This allows the food inside to achieve commercial sterility, providing long-term shelf stability at ambient storage conditions without refrigeration for extended periods.

140. (B) Ability to form a strong, hermetic heat seal that withstands retort temperatures
The innermost polymer layer of a retort pouch, typically made of cast polypropylene, must possess the critical ability to form a highly robust and hermetic heat seal. This seal must remain physically stable and maintain its mechanical integrity under the extreme temperatures and overpressures experienced during the retorting sterilization process.

141. (B) To provide an absolute barrier to oxygen, light, and moisture
The aluminum foil layer in a three-ply retort pouch structure serves as an absolute barrier

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102. (B) To allow the inner butter matrix to breathe and dry out continuously
Vegetable parchment paper and aluminum foil wraps are used for butter because they resist grease and water. While aluminum foil blocks light and oxygen to prevent rancidity, parchment allows a controlled release of excess surface moisture. This balances moisture levels, preventing mold growth without letting the butter dry out completely during storage.

103. (C) Heated gaseous hydrogen peroxide
Aseptic packaging lines typically sterilize the packaging material, such as carton roll stock, using heated gaseous hydrogen peroxide. This chemical sterilant is applied to the surface and then evaporated using sterile hot air, leaving a sterile, dry container ready for filling with UHT milk under aseptic environmental conditions.

104. (D) The package requires moisture barriers while letting carbon dioxide gas escape.
Certain natural cheeses, like Swiss, continue to release carbon dioxide gas after packaging due to active bacterial cultures. If packaged in an absolute barrier, the gas will build up, causing the package to bloat. The material must allow carbon dioxide to escape while keeping moisture inside to prevent drying of the cheese.

105. (A) P-2, Q-3, R-4, S-1
UHT milk requires sterile filling into multi-layered aseptic cartons. Butter needs protection from light, oxygen, and odors to prevent lipid oxidation, while Swiss cheese requires packaging that allows carbon dioxide to escape. Ice cream requires materials that resist low temperatures and prevent moisture loss, matching each dairy product with its specific packaging needs.

106. (B) Packaging sterile product into sterile containers under aseptic conditions.
Aseptic packaging involves sterilizing the food product and the packaging material separately. The sterile food is then filled and sealed inside the sterile container within a highly controlled, sterile environment. This method extends shelf life for months without requiring chemical preservatives or continuous refrigeration during storage.

107. (B) Aluminum foil
In an aseptic carton laminate, the aluminum foil layer provides the primary barrier against oxygen, light, and external odors. Even at very thin levels, its metal structure blocks gas and light transmission, protecting UHT milk from oxidation and nutritional loss, which allows the product to be safely stored at room temperature.

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108. (A) To replace oxygen with N_2 and CO_2 to inhibit mold growth and clumping
Modified atmosphere packaging is used for shredded cheese to displace oxygen with carbon dioxide and nitrogen. Removing oxygen inhibits mold growth and prevents lipid oxidation. Carbon dioxide acts as an antimicrobial agent, while nitrogen acts as an inert filler that prevents the cheese shreds from clumping together under high vacuum.

109. (C) Mechanical rigidity and shape retention
The paperboard layer in an aseptic milk carton provides mechanical strength, rigidity, and shape retention. While it does not act as a barrier to moisture or gases, it forms the structural frame that allows the carton to be stacked, handled, and displayed on retail shelves without collapsing under its own weight.

110. (D) To alter internal gaseous environments specifically to extend shelf life
Modified atmosphere packaging is designed to replace the normal atmospheric air inside a package with a specific mixture of gases. This altered atmosphere limits chemical degradation and microbial growth, extending the shelf life of perishable foods. It is not used to speed up ripening or freeze products without using electricity.

111. (C) Nitrogen (N_2)
Nitrogen is an inert gas with low solubility in water and fats. In modified atmosphere packaging, it is used to displace oxygen and fill the head space. This prevents the package from collapsing when carbon dioxide dissolves into the food, maintaining the package's structural shape during long-term storage and transport.

112. (B) It dissolves in water to inhibit aerobic bacteria and mold growth.
Carbon dioxide is added to modified atmosphere packaging because it dissolves into the food's water and lipid phases, forming carbonic acid. This acidification lowers the pH and interferes with cell membrane function, inhibiting the growth of aerobic bacteria and molds, which

151. (D) To convert microwave energy to sensible heat for localized browning and crisping
Microwave susceptors are active packaging elements designed to absorb electromagnetic energy and convert it into sensible heat. This rapid conversion generates localized high temperatures on the food surface, enabling critical culinary reactions like crisping and browning on products such as pizzas or pies, which would otherwise remain soggy in a microwave.

152. (B) A thin, metallized aluminum layer deposited on a high-temperature PET substrate
A typical microwave susceptor is constructed by depositing an extremely thin, metallized aluminum layer onto a heat-resistant polyethylene terephthalate film substrate. This micro-thin metal layer has the correct electrical resistance to absorb microwave energy and convert it into high heat, which is then transferred conductively to the food surface for browning.

153. (C) Shielding uses thick metal foil to block microwaves, preventing localized overcooking
Microwave shielding utilizes thick, solid metal foil sections integrated into the packaging to completely block electromagnetic waves from reaching specific portions of the food. By reflecting the radiation, shielding prevents sensitive ingredients from overcooking or drying out, enabling balanced, controlled heating across products with highly diverse composition and thermal properties during cooking.

154. (D) They reflect microwaves, causing arcing near oven walls and preventing food heating
Conventional aluminum foil trays are problematic in household microwaves because their thick metal surfaces highly reflect electromagnetic waves. This reflection prevents the waves from penetrating and heating the food effectively. Furthermore, it creates concentrated electrical fields that can cause arcing near the metal oven walls, posing a serious risk of fire.

155. (A) I, II and IV
Susceptors are widely used to achieve localized browning and crisping in products like popcorn and pizza, while microwaves heat food primarily through interaction with polar water molecules. Highly heat-resistant containers like polypropylene can deform if the food contains high sugar or fat, as these components can heat beyond the polymer's melting point during cooking.

156. (B) Cylindrical or round shapes that prevent localized corner overheating
Cylindrical or round package geometries promote uniform heating in microwave ovens by eliminating sharp corners. Sharp angles act as focal points that concentrate electromagnetic field lines, leading to localized overheating and dry edges. Round profiles facilitate an even distribution of microwave penetration, helping to balance thermal energy distribution throughout the liquid food matrix.

157. (B) A self-venting mechanism or valve to prevent explosive steam rupture
Microwavable steam bags designed for vegetables must incorporate a reliable self-venting mechanism or valve. As the water within the vegetables heats and vaporizes, high-pressure steam builds up inside the sealed pouch. The self-venting valve releases excess steam safely, preventing explosive pressure rupture while maintaining a moist cooking environment inside the package.

158. (A) Edge-heating or corner concentration effect
The phenomenon where the edges of a square microwavable meal cook much faster than the center is called the edge-heating or corner concentration effect. This occurs because electromagnetic waves penetrate the food container from multiple sides simultaneously at the boundaries, concentrating energy in the outer margins and corners while the center relies on slower thermal conduction.

159. (C) Polymers derived from renewable biological sources and/or those that are biodegradable
In food packaging, a biopolymer is defined as a polymeric material that is either synthesized from renewable biological resources, such as agricultural byproducts or plant starches, or is capable of undergoing complete biodegradation. These environmentally friendly materials serve as sustainable alternatives to petroleum-derived plastics, reducing carbon footprints and municipal waste accumulation.

160. (D) Polylactic Acid (PLA)
Polylactic Acid is a bio-based polyester synthesized through the ring-opening polymerization of lactide monomers, which are

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obtained by fermenting plant-derived starches from crops like corn. This biopolymer offers outstanding optical clarity, high tensile strength, and rigidity, making it a prominent candidate for thermoformed cups, clear trays, and various short-term food packaging applications.

161. (C) By intracellular bacterial fermentation as energy storage under stress
Polyhydroxyalkanoates are biopolyesters synthesized naturally by various bacterial species during fermentation processes. Under conditions of nutrient limitation coupled with an excess of carbon sources, bacteria accumulate these polymers inside their cells as carbon and energy storage reserves. The accumulated polymer is subsequently extracted and purified for use in biodegradable packaging structures.

162. (B) PLA has a low glass transition temperature, making it unfit for hot-fill
A primary limitation of standard polylactic acid films is their relatively low glass transition temperature, typically around fifty-five to sixty degrees Celsius. This property makes the polymer susceptible to thermal softening and structural deformation at elevated temperatures, rendering it unsuitable for hot-fill beverage operations or high-temperature packaging processes in food industries.

163. (D) Initial thermal hydrolysis triggered by moisture, followed by microbial assimilation
In industrial composting systems, the degradation of polylactic acid proceeds via a two-step mechanism. High temperature and high humidity first trigger abiotic thermal hydrolysis, breaking down the long polyester chains into shorter, soluble oligomers. Once the molecular weight is sufficiently reduced, indigenous microorganisms assimilate these fragments, converting them into carbon dioxide, water, and biomass.

164. (A) Polycaprolactone (PCL) - Extracted directly from marine algae
Polycaprolactone is a biodegradable, petroleum-derived synthetic polyester synthesized via the ring-opening polymerization of epsilon-caprolactone. It is not extracted from marine algae, making the pair incorrect. Conversely, polylactic acid originates from fermented plant carbohydrates, polyhydroxyalkanoates are biosynthesized intracellularly by bacteria, and natural cellulose is derived directly from plant structural fiber matrices.

165. (C) A is true but R is false.
While polylactic acid is derived from renewable sources, it requires the high temperature and moisture conditions found in industrial composting facilities to degrade efficiently. Standard home compost bins and cool soils lack the elevated thermal profiles required to initiate the initial hydrolysis of the polymer backbone, making the assertion true while the reason is false.

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166. (A) Polyhydroxybutyrate
Polyhydroxybutyrate is a short-chain-length polyhydroxyalkanoate that is biosynthesized by bacterial fermentation. This specific biopolymer is highly crystalline and characterized by high stiffness, brittleness, and a narrow thermal processing window, which often limits its standalone application in flexible film packaging unless it is blended with plasticizers or other softer biodegradable packaging polymers.

167. (D) Blending with other polymers, plasticizers, or using multilayer coextrusion
To overcome the inherent physical limitations of standalone biopolymers, such as the brittleness and poor barrier properties of starch or polylactic acid, manufacturers commonly employ compounding strategies. Blending these materials with other biodegradable polymers, incorporating functional plasticizers, or utilizing multilayer coextrusion techniques successfully enhances film flexibility, moisture resistance, and overall packaging performance.

168. (B) High hydrophilicity and moisture sensitivity, causing mechanical strength loss
Thermoplastic starch is highly hydrophilic due to the presence of numerous hydroxyl groups along its molecular chains. This chemistry makes it extremely sensitive to moisture, causing the material to rapidly absorb water from high-moisture foods or humid environments. This sorption leads to severe plasticization, loss of mechanical strength, and compromised barrier properties.

169. (C) Films are pre-formed solid sheets; coatings are applied as liquids directly on food
The fundamental distinction between edible films and edible coatings lies in their method

of preparation and application. Edible films are pre-formed, independent solid sheets that are manufactured separately and then applied to cover the food. In contrast, edible coatings are applied directly onto the food surface in liquid form and subsequently dried to solidify.

170. (D) Lipids (e.g., beeswax, carnauba wax)
Lipids, such as beeswax and carnauba wax, are highly hydrophobic chemical structures that exhibit excellent resistance to water vapor transport. Consequently, this class of edible film materials provides the most effective barrier against moisture transmission, helping to reduce weight loss and dehydration in packaged food products compared to hydrophilic polysaccharide or protein-based alternatives.

171. (A) They tend to be opaque, brittle, and can impart a waxy off-taste
While lipid-based edible coatings offer excellent moisture barrier properties, they are limited by their poor mechanical characteristics. These formulations tend to be highly brittle and often lack optical clarity, appearing opaque. Additionally, when applied in thick layers, they can impart an undesirable waxy mouthfeel and off-taste, affecting the sensory attributes of the food.

172. (B) Whey protein isolate
Whey protein isolate is a highly functional protein widely used to fabricate transparent, cohesive edible films. The highly ordered three-dimensional network formed by the cross-linked proteins provides an excellent barrier against oxygen and other gases under low relative humidity conditions, helping to prevent lipid oxidation and preserve food quality during storage.

173. (B) To enhance film flexibility and handling by lowering intermolecular forces
Polysaccharide-based edible films are naturally stiff and brittle because of extensive hydrogen bonding along their chains. Adding a low-molecular-weight plasticizer, such as glycerol or sorbitol, interrupts these strong polymer-polymer interactions. This increase in free volume and molecular mobility significantly enhances film flexibility, handling, and elongation while reducing mechanical brittleness during subsequent processing.

174. (A) They typically provide good gas barriers but exhibit poor moisture barriers
Polysaccharide-based edible films form highly cohesive, hydrogen-bonded structures that provide an excellent barrier to gases like oxygen and carbon dioxide under dry conditions. However, due to their hydrophilic nature, they easily absorb moisture, resulting in poor water vapor barrier properties and a tendency to dissolve or swell when in contact with high-moisture foods.

175. (A) P-3, Q-1, R-4, S-2
Beeswax serves as an exceptional hydrophobic barrier against moisture transfer, while glycerol is a key plasticizer that enhances film flexibility. Chitosan is a natural polysaccharide with inherent antimicrobial activity against food pathogens, and whey protein provides structural cohesion and an excellent oxygen barrier, demonstrating how composite formulations optimize edible packaging functionality.

176. (D) Dipping or spraying the liquid emulsion onto food, followed by drying
Applying edible coatings to whole fresh fruits, such as apples, is standardly achieved through dipping or spraying liquid formulations directly onto the peel. This process ensures complete and uniform coverage across the irregular contours of the fruit. Subsequent drying evaporates the solvent, leaving a thin, protective polymer layer that reduces transpiration and enhances surface gloss.

177. (C) By combining lipids and proteins to leverage the unique barrier properties of both
Composite edible films are engineered by combining proteins or polysaccharides with lipids to construct a multi-component matrix. This formulation strategy successfully leverages the mechanical strength and gas barrier properties of hydrophilic polymers alongside the superior water-vapor resistance of hydrophobic lipids, optimizing the overall preservation performance of the packaging layer during storage.

178. (A) Sorbed molecules act as plasticizers, causing swelling, loss of barriers, and weak seals
When polymers absorb lipophilic food constituents, such as essential oils or lipids, these sorbed molecules act as internal plasticizers. This chemical interaction increases the free volume between polymer chains, leading to

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These standardized units enable simple, uniform comparison of migration data across diverse packaging shapes, thicknesses, and materials globally.

215. (A) Increasing storage temperature and contact time
Increasing the ambient storage temperature and the total contact duration dramatically accelerates the rate of chemical migration from a polymer into food. Higher temperatures increase the kinetic energy of the system, which boosts the diffusion coefficient of migrant molecules within the plastic matrix, facilitating their rapid mass transfer across the interface.

216. (B) I, III and IV
Specific Migration Limits are strictly derived from established toxicological profiles, and high temperatures significantly accelerate diffusion coefficients within the polymer matrix. Additionally, food simulants are selected based on the hydrophilic, lipophilic, or acidic nature of the food. Conversely, migration is typically lower in dry, solid foods than in liquid, fatty foods.

217. (B) It finds the total substance present to assume a worst-case 100% migration scenario
Extraction testing is sometimes performed as a rapid screening alternative to migration testing. By exposing the packaging material to harsh solvents and temperatures, it extracts the total quantity of a substance present, allowing analysts to assume a worst-case one hundred percent migration scenario to quickly verify safety without long-term analytical testing.

218. (C) Bisphenol-A (BPA)
Bisphenol-A is a synthetic organic compound notoriously associated with migration from polycarbonate plastic containers and the epoxy resin protective linings of metal food cans. This chemical is utilized during polymer synthesis to create high-clarity and durable materials, but residual, unreacted monomers can subsequently leach into packaged foods over extended food product storage.

219. (D) It acts as an endocrine disruptor, potentially mimicking natural estrogen
The primary toxicological concern surrounding Bisphenol-A is its ability to act as an endocrine disruptor. At a molecular level, the chemical structurally resembles human estrogen and can bind to estrogen receptors, potentially interfering with hormonal systems. This raises concerns regarding developmental, reproductive, and metabolic health effects in consumers exposed to leaching.

220. (A) As plasticizers added to PVC to provide flexibility
Phthalates are organic compounds widely used as plasticizers to provide flexibility, elasticity, and ease of processing in polyvinyl chloride plastics. Because they are not chemically bound to the polymer matrix, they can readily migrate out of the film, presenting a high risk of contamination when in direct contact with lipophilic, fatty foods.

221. (B) Styrene monomer can migrate from polystyrene into hot drinks, causing safety and off-flavor issues
Styrene monomers can migrate from expanded polystyrene containers into hot beverages or fatty foods, causing distinct off-flavors and raising toxicity concerns. This phenomenon is highly temperature-dependent, as elevated thermal conditions accelerate the diffusion of unreacted styrene molecules from the polymer matrix into the food, demonstrating the dynamic nature of chemical migration.

222. (B) Fickian diffusion driven by concentration gradients and partition coefficients
The migration of plasticizers from a polyvinyl chloride film into a high-fat cheese is best described by Fickian diffusion. This mass transfer model is driven by concentration gradients across the interface and governed by the partition coefficient between the polymer and the food, which dictate the rate and equilibrium concentration of chemical transfer.

223. (A) Transitioning to BPA-free alternatives like BPS or polyester-based can coatings
Global regulatory scrutiny over the estrogenic effects of Bisphenol-A has catalyzed a major industrial shift. Food manufacturers and chemical suppliers are transitioning to alternative, BPA-free coatings for the interior of metal cans, typically utilizing polyester-based lacquers, polyethersulfone resins, or alternative bisphenols like BPS to ensure food safety compliance during product storage.

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effective superabsorbent polymers that trap the released purge, preventing surface microbial proliferation, eliminating unsightly appearance, and reducing chemical deterioration associated with food products sitting in stagnant liquids during commercial display.

188. (A) To act as an effective anti-mold agent in high-moisture bakery products
Ethanol emitters are highly effective active packaging components designed to slowly release ethanol vapor into the package headspace. This volatile compound acts as a powerful anti-mold agent, particularly in high-moisture bakery products like pre-baked breads and cakes. The vapor penetrates the surface of the food, inhibiting fungal spore germination and significantly extending microbial stability.

189. (B) It requires a dose of UV light during the packaging process to trigger a photo-oxidation reaction that subsequently consumes oxygen inside the package
A UV-activated oxygen scavenging polymer film remains completely stable and inactive during storage. When the packaging line is running, a controlled dose of ultraviolet light is applied to the film, which excites a photo-sensitizer. This triggers a localized photo-oxidation reaction that subsequently and continuously consumes residual headspace oxygen once the package is sealed and filled.

190. (B) It senses and provides information about the food's condition or environment
Intelligent or smart packaging is defined by its ability to sense, monitor, and communicate vital information regarding the actual state of the food product, the package integrity, or the historical environment. Unlike active packaging, which directly preserves the food, intelligent systems act as informative devices that facilitate quality control and decision-making throughout the logistics chain.

191. (A) The cumulative exposure to time and temperature, reflecting thermal abuse
Time-Temperature Indicators are intelligent devices attached to food packages that monitor the cumulative exposure to thermal conditions over time. These sensors undergo an irreversible chemical, physical, or enzymatic change that results in a visible color alteration, directly reflecting the degree of temperature abuse and predicting the remaining shelf life of temperature-sensitive products.

192. (C) A temperature-dependent enzymatic reaction causing a visible color change
Enzymatic Time-Temperature Indicators operate based on a temperature-dependent enzymatic reaction, typically involving the hydrolysis of a lipid substrate by a lipase enzyme. This chemical reaction releases acids that lower the pH of the system, triggering a pH-sensitive redox or color indicator to change color visually, reflecting the historical cumulative thermal exposure of the product.

193. (D) To detect volatile spoilage metabolites and display a visible color change
Freshness sensors in meat packaging are intelligent indicators that directly detect volatile basic metabolites, such as ammonia, dimethylamine, or biogenic amines, which are produced during microbial spoilage. As these gaseous compounds accumulate in the package headspace, they react chemically with a sensitive dye in the sensor, causing a distinct, visible color change.

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194. (C) A leak indicator that changes color when exposed to atmospheric oxygen
Verification of the structural integrity of Modified Atmosphere Packaging requires a leak indicator that changes color upon contact with oxygen. Since MAP headspace contains little to no oxygen, any physical breach in the hermetic seal allows atmospheric oxygen to leak in. The indicator senses this chemical change and provides a clear visual signal to consumers.

195. (B) Intelligent packaging systems are designed to chemically preserve the food.
Intelligent packaging is designed strictly to monitor product conditions and transmit data, rather than directly acting to preserve the food chemically. Hence, claiming that these systems are designed to preserve food is incorrect. Sensors and indicators, including time-temperature devices, leak detectors, and freshness indicators, offer valuable diagnostic information regarding the quality of perishable cargo.

196. (A) I, II and IV
Time-temperature indicators visually display historical exposure to thermal abuse, while oxygen indicators utilize redox dyes such as methylene blue to indicate package leakage.

(C) Complete metabolic suppression of all active colonic fermentation processes
(D) Modulation of the microbiome to exclude intestinal pathogens

2018
18. Which statement represents a common misconception about the human gut microbiome?
(A) The microbiome profile remains static from birth
(B) Dietary composition plays the single predominant role in shaping human microbial diversity
(C) Endogenous gut bacteria synthesize essential micronutrients such as Vitamin K
(D) Any quantitative or qualitative imbalance in the microbiome is termed dysbiosis

2011
19. How do dietary antioxidants biochemically protect structural lipids within cell membranes?
(A) By directly replacing structural membrane phospholipids
(B) By increasing the biological solubility of membrane proteins
(C) By terminating lipid peroxidation
(D) By selectively binding to intracellular divalent calcium ions

2004
20. Which of the following is the least relevant application of gut microbiome modulation via functional foods?
(A) Altering host genetic sequences permanently
(B) Enhancing systemic immune responses
(C) Improving mineral absorption in the colon
(D) Alleviating symptoms of irritable bowel syndrome

2007
21. Which compound acts as a natural antioxidant inherently present in bovine milk?
(A) Ascorbic acid in high concentrations
(B) Butylated hydroxytoluene (BHT)
(C) Tertiary butylhydroquinone (TBHQ)
(D) Alpha-tocopherol

2022
22. What is currently the most dominant segment in the global dairy nutraceuticals market?
(A) Demineralized whey powder utilized for commercial baking
(B) Probiotic and fermented milks
(C) Low-lactose skim milk designed for lactose-sensitive consumers
(D) Confections formulated using dairy-derived ghee residues

2002
23. Which factor serves as the primary driver for the commercialization of dairy health foods in India?
(A) A massive decrease in per capita income
(B) Strict bans on traditional dairy products
(C) Rising consumer awareness regarding preventive healthcare
(D) The absolute elimination of lactose intolerance in the population

2023
24. What best defines the concept of market positioning for a novel functional dairy product?
(A) The literal physical placement of the finished product on a retail supermarket shelf
(B) Formulating the therapeutic product to be significantly cheaper than basic fluid milk
(C) Completely ignoring standard competitive pricing models to focus on aesthetic packaging
(D) Defining health benefits in the mind of the consumer

2006
25. Match the dairy nutraceutical products in List I with their primary target demographic in List II.
List I: (Dairy nutraceutical products)
P. Humanized infant formula
Q. Plant-sterol enriched yogurt
R. High-BCAA whey isolate
S. Calcium-fortified easily digestible milk
List II: (Target demographic)
1. Geriatric population
2. Athletes and bodybuilders
3. Cardiovascular risk patients
4. Neonates
(A) P-4, Q-3, R-2, S-1
(B) P-3, Q-4, R-1, S-2
(C) P-4, Q-1, R-2, S-3
(D) P-1, Q-3, R-4, S-2

2023
26. Which demographic is predominantly driving the global demand for bone-health dairy nutraceuticals?
(A) Adolescents and growing teenagers undergoing rapid skeletal development
(B) Aging and post-menopausal women
(C) Professional marathon runners and high-endurance elite athletes
(D) Infants and young toddlers undergoing the biological weaning phase

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boxes gain up to two-thirds of their compressive strength from their vertical corners, overhang removes this support. This critical misalignment can reduce the cumulative compression strength of the stack by up to forty percent.

206. (A) I and II
Stretch wrapping represents a highly efficient, primary method for securing palletized unit loads, preventing shifting during transport. Additionally, inserting anti-slip sheets between layers of secondary cartons increases physical friction, significantly reducing horizontal sliding. Conversely, strapping is widely used to secure extremely heavy or bulky loads, making the claim of its light-load limitation incorrect.

207. (A) The efficiency with which available three-dimensional transport space is filled
Cube utilization represents a core logistical performance indicator that quantifies the volumetric efficiency of transport and storage operations. It measures the percentage of three-dimensional space within a shipping container or truck trailer that is physically occupied by freight, guiding engineers to minimize empty space and optimize distribution costs during international transit.

208. (C) Heat-treated or fumigated wood, plastic, or synthetic slip sheets
Under international regulations like ISPM fifteen, wood packaging materials utilized for export must undergo specific treatments to eliminate biological pests. This mandate is fulfilled by using heat-treated or chemically fumigated timber pallets, plastic structures, or synthetic slip sheets, which successfully prevent the transboundary transmission of destructive forest insects during transport.

209. (D) Interlocking increases lateral stability but can reduce compressive strength by up to 50%
Interlocking stacking patterns rotate successive layers of cartons to secure them together, significantly improving the lateral stability of the unit load against tipping. However, because the vertical corners are misaligned with the layers below, this pattern can reduce the overall compressive load-bearing strength of the stack by up to fifty percent.

210. (C) The maximum total mass of all non-volatile substances migrating into food or simulants
The Overall Migration Limit is a critical regulatory safety threshold that defines the maximum cumulative mass of all non-volatile chemical compounds transferring from a packaging material into food or food simulants. This limit ensures that the packaging remains inert and does not cause unacceptable alterations in food composition or sensory attributes.

211. (B) Rectified olive oil or synthetic triglycerides
In migration testing protocols, rectified olive oil or specific mixtures of synthetic triglycerides are designated as the official food simulants for fatty and lipophilic products. These oily liquid simulants physically mimic the extraction capability and partition characteristics of lipophilic foods, enabling accurate assessment of chemical migration from plastic materials during storage.

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212. (D) The migration of individual toxic substances to ensure they remain below safe thresholds
The Specific Migration Limit is a health-based regulatory standard established for individual, chemically identified substances present in packaging materials. It restricts the maximum permitted concentration of a specific compound, such as a monomer, plasticizer, or catalyst, that can transfer into food, ensuring consumer exposure remains well below established toxicological safety thresholds.

213. (A) OML testing is always conducted using complex mass spectrometry to identify every chemical.
Overall migration testing measures the total mass of non-volatile residues transferring into food simulants using simple gravimetric evaporation techniques, rather than complex mass spectrometry to identify every single chemical, making that statement incorrect. Conversely, testing uses specific simulants like acetic acid and is conducted under accelerated worst-case times and temperatures during analysis.

214. (C) Milligrams of residue per square decimeter of surface (mg/dm^2) or per kg of simulant
In regulatory compliance documentation, the Overall Migration Limit is standardly expressed as milligrams of residue per square decimeter of packaging contact surface area or as milligrams of chemical per kilogram of food simulant.

physical swelling, loss of mechanical strength, a substantial decrease in gas barrier properties, and potential mechanical failure of heat-sealed regions over storage.

179. (B) Chitosan
Chitosan is a natural cationic polysaccharide derived from the deacetylation of chitin, which is harvested from the exoskeletons of crustaceans. Because of its positively charged amino groups, chitosan interacts with negatively charged microbial cell membranes, exerting inherent, broad-spectrum antimicrobial activity that makes it highly popular for active edible preservation coatings on fresh produce.

180. (D) It incorporates components that release or absorb substances to extend shelf life
Active packaging differs from passive systems by dynamically interacting with the internal environment of the package. It incorporates specific active substances or components within the material structure or headspace that directly absorb unwanted components, such as oxygen, water vapor, or ethylene, or release beneficial compounds, such as antimicrobials and antioxidants, to extend food stability.

181. (A) It oxidizes iron powder, irreversibly consuming headspace oxygen
Iron-based oxygen scavenging sachets function through a chemical oxidation reaction. When exposed to the residual oxygen in the package headspace, the moist iron powder inside the sachet undergoes a controlled chemical reaction to form iron oxides. This process irreversibly consumes the surrounding oxygen, successfully lowering the concentration to levels below zero point zero one percent.

182. (C) Ethylene is a ripening hormone; absorbing it delays decay and over-ripening
Climacteric fruits produce and respond to ethylene gas, which acts as a powerful natural hormone that accelerates ripening, senescence, and eventual decay. Incorporating active ethylene absorbers within the food packaging removes this hormone from the headspace. Consequently, this chemical scrubbing successfully delays physiological breakdown, maintaining fruit firmness and extending commercial shelf life.

183. (A) Potassium permanganate ($KMnO_4$) on a silica carrier
Potassium permanganate is a powerful oxidizing agent widely utilized in ethylene-absorbing active packaging. To maximize its contact efficiency, the compound is impregnated onto a porous carrier with a high surface area, such as silica gel or active alumina. The incoming gaseous ethylene reacts chemically with the permanganate, which oxidizes it into harmless carbon dioxide and water.

184. (D) They absorb headspace moisture to maintain low water activity and crispness
Desiccants or active moisture regulators play a critical role in preserving dry, crispy foods by actively absorbing water vapor from the package headspace. This chemical or physical trapping maintains a very low relative humidity and water activity within the container, preventing the food product from absorbing moisture, becoming soggy, and undergoing rapid physical or microbiological spoilage.

185. (B) Antimicrobial packaging is designed to completely sterilize heavily contaminated spoiled food.
Antimicrobial active packaging is designed to inhibit or delay the growth of target microorganisms on the food surface, but it cannot sterilize or salvage heavily contaminated or spoiled products. Hence, stating that it sterilizes such food is incorrect. Antimicrobials can be incorporated into polymer matrices, use silver nanoparticles, or release volatile essential oils to maintain hygiene.

186. (A) II, IV, I, III
The active mechanism of a moisture-activated volatile antimicrobial packaging system begins when high relative humidity from the food product permeates the emitting pad. This moisture trigger initiates a chemical reaction that releases the active volatile compound, which then accumulates within the package headspace. Finally, these antimicrobial vapors interact with the food surface to suppress microbial growth.

187. (D) Moisture-absorbing drip pads that utilize superabsorbent polymers
Fresh poultry packaging frequently utilizes moisture-absorbing drip pads located at the bottom of the container to manage excess fluid exudate. These specialized pads contain highly

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224. (C) Through set-off on rolls, where the printed outer surface contacts the inner layer.
Printing inks on the exterior of a package can pose a migration hazard through a physical mechanism known as set-off. During the manufacturing process, when printed plastic films or paperboards are tightly wound into massive rolls, the printed outer surface comes into direct, pressurized contact with the unprinted inner food-contact layer, transferring volatile chemical compounds.

225. (D) Sorption of volatile flavor compounds from food into the polymer, causing aroma loss
In mass transfer chemistry, flavor scalping refers to the undesirable sorption of volatile food aroma compounds into the organic polymer structure of the package wall. This physical absorption removes critical volatile molecules from the food product, leading to a significant loss of aroma intensity, alteration of flavor profiles, and reduced overall product quality.

226. (B) I, III, IV
Flavor scalping occurs readily when lipophilic volatile flavor compounds interact with lipophilic polymers, while permeation describes the mass transfer of gases or vapors completely through the package wall. Additionally, the sorption of ingredients can alter the mechanical and barrier properties of the polymer. Conversely, glass displays zero flavor scalping, and migration transfers compounds into food.

227. (B) Citrus juices in LDPE-lined cartons due to d-limonene sorption
Citrus juice packaged in low-density polyethylene-lined cartons is highly susceptible to quality degradation via flavor scalping. The non-polar, lipophilic polymer rapidly absorbs d-limonene, which is the primary volatile compound responsible for the fresh citrus aroma. This absorption results in a rapid loss of fresh taste and unbalanced flavor profiles during product distribution.

228. (D) Migration, permeation, sorption
In food-packaging interactions, the three primary mass transfer phenomena are migration, permeation, and sorption. Migration describes the transfer of substances from the packaging into the food. Permeation represents the passage of external gases or vapors through the packaging wall. Sorption involves the absorption of food constituents, such as flavor compounds or fats, by the packaging material.

229. (A) It describes the equilibrium concentration ratio of a migrant between food and packaging
The partition coefficient is a thermodynamic ratio that describes the equilibrium distribution of a migrating chemical compound between the polymer packaging material and the food phase. This value dictates whether a chemical has a higher affinity for the food matrix or will remain trapped inside the polymer, determining the ultimate extent of migration.

230. (A) Sorbed molecules act as plasticizers, causing swelling, loss of barriers, and weak seals
When polymers absorb lipophilic food constituents, such as essential oils or lipids, these sorbed molecules act as internal plasticizers. This chemical interaction increases the free volume between polymer chains, leading to physical swelling, loss of mechanical strength, a substantial decrease in gas barrier properties, and potential mechanical failure of heat-sealed regions over storage.

NODIA

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CHAPTER 10

Functional Foods, Nutraceuticals, Novel Dairy Ingredients

2003

1. Which of the following strictly defines a functional food under food safety regulations?
(A) A standardized pharmaceutical tablet formulation containing synthetic vitamins
(B) A traditional herbal formulation prepared solely for curing acute diseases
(C) A highly processed, refined dietary matrix lacking endogenous micronutrients
(D) A food formulation offering physiological benefits beyond basic nutrition

2017

2. Which specific substantiation is mandatory for making a valid health claim on a dietary supplement?
(A) Human clinical trials demonstrating physiological efficacy
(B) Traditional anecdotal evidence lacking controlled clinical testing
(C) Basic in vitro antioxidant assays assessing radical scavenging
(D) Consumer preference surveys assessing taste and palatability

2018

3. Consider the following statements regarding Indian nutraceutical regulations:
I. Nutraceuticals must not claim to cure or mitigate any specific disease.
II. FSSAI requires all functional foods to be marketed as Schedule H drugs.
III. Nutraceuticals can contain ingredients listed in Schedule VI.
Which of the above statements are correct?
(A) I and II
(B) Only II
(C) I and III
(D) Only III

2007

4. Which statement correctly differentiates dietary supplements from standard foods?
(A) Supplements are sold in dose forms like powders or capsules
(B) Supplements are consumed primarily to meet basic daily caloric density
(C) Supplements are designed to serve as the sole source of daily nutrition
(D) Supplements are completely exempt from routine heavy metal toxicity assays

2022

5. Which regulatory body is responsible for establishing international standards for functional food labeling to facilitate global trade?
(A) Food Safety and Standards Authority of India
(B) United States Food and Drug Administration
(C) European Food Safety Authority
(D) Codex Alimentarius Commission

2005

6. What is the primary cause of regulatory rejection for a proposed functional dairy product?
(A) The formulation of products containing scientifically validated probiotic strains
(B) Marketing products with unapproved disease risk reduction claims
(C) Maintaining standardized milk protein fractions such as whey to casein ratios
(D) Utilizing approved food-grade carrier materials for active encapsulation

2021

7. Which of the following statements is INCORRECT regarding standards for functional foods?
(A) Ingredients must have a documented historical record of safe utilization
(B) Formulations must strictly adhere to comprehensive microbiological criteria
(C) Products can replace medical therapies for chronic illness
(D) Food additives must remain within officially prescribed permissible limits

2009

8. When defining nutraceuticals, which characteristic is the most relevant parameter?

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(A) The aesthetic and sensory enhancement of the final food product matrix
(B) The substantial reduction of industrial food manufacturing overhead costs
(C) The extension of the packaged product shelf life under ambient storage
(D) The presence of purified bioactives conferring health benefits

2017
9. Which of the following is NOT covered under the regulations for health supplements and nutraceuticals?
(A) Injectable pharmaceutical antibiotics
(B) Foods for Special Dietary Uses (FSDU)
(C) Foods for Special Medical Purposes (FSMP)
(D) Prebiotic and probiotic foods

2007
10. How does a "nutrient content claim" differ fundamentally from a "health claim"?
(A) Both claims mean exactly the same thing in international trade
(B) A nutrient claim describes the level of a nutrient, while a health claim describes its physiological effect
(C) A health claim specifies the weight of the ingredient, whereas a nutrient claim specifies disease reversal
(D) Nutrient claims require clinical trials, whereas health claims do not

2022
11. Which basic nutritional mechanism allows dietary fibers to interact beneficially with the gut microbiome?
(A) Complete enzymatic absorption of intact complex fiber in the small intestine
(B) Colonic fermentation producing short-chain fatty acids
(C) Direct enzymatic breakdown of complex carbohydrates by host pancreatic amylase
(D) Direct and competitive inhibition of all beneficial bacterial colon growth

2021
12. What defines the primary biochemical action of an antioxidant in a functional food matrix?
(A) Neutralizing free radicals by donating an electron
(B) Increasing the oxidative reduction potential of the food
(C) Accelerating lipid auto-oxidation to enhance flavor
(D) Binding selectively to essential amino acids

2024
13. Which short-chain fatty acid is specifically renowned for acting as the primary energy source for colonocytes?
(A) Acetate
(B) Propionate
(C) Butyrate
(D) Valerate

2010
14. Which of the following statements is correct regarding soluble versus insoluble dietary fiber in human nutrition?
(A) Insoluble fiber readily forms highly viscous gel structures that lower cholesterol absorption
(B) Soluble fiber acts primarily by adding physical bulk to the stool to prevent constipation
(C) Neither category of dietary fiber has any physiological impact on digestive transit times
(D) Soluble fiber is more fermentable by gut microbiota than insoluble fiber

2003
15. Given the assertion (A) and reason (R), choose the correct option.
Assertion (A): Consumption of antioxidant-rich foods reduces oxidative stress in the body.
Reason (R): Antioxidants act as catalysts to increase the production of reactive oxygen species in cellular mitochondria.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

NODIA

2013
16. In the classification of functional ingredients, which of the following is strictly categorized as a prebiotic?
(A) Lactobacillus rhamnosus bacterial strain
(B) Fructooligosaccharides
(C) Alpha-tocopherol antioxidant compound
(D) Conjugated Linoleic Acid active lipid

2008
17. What is the physiological effect of consuming a diet rich in non-starch polysaccharides?
(A) Rapid and significant elevation of postprandial blood glucose levels
(B) Immediate and direct degradation of the protective gut mucosal lining

Radio-frequency identification tags represent an advanced electronic form of intelligent packaging used to improve logistics, traceability, and stock control, demonstrating how modern smart systems communicate product and environmental history.

197. (A) Volatile basic amines from spoilage that raise pH and alter dye color
Fish spoilage is heavily characterized by the microbial degradation of proteins and amino acids, which produces volatile basic nitrogenous compounds. As these basic amines accumulate in the closed package, they dissolve in the sensor matrix, increasing the pH. This chemical change triggers a pH-dependent dye in the indicator to alter its color visually.

198. (C) A dyed indicator liquid diffuses along a porous wick at a temperature-dependent rate
A polymer-based diffusion Time-Temperature Indicator operates through physical capillary action. It consists of a reservoir containing a dyed chemical liquid and a porous wick. When exposed to heat, the viscosity of the liquid decreases, allowing it to diffuse along the wick at a temperature-dependent rate, providing a visual measurement of cumulative thermal exposure.

199. (A) It must match the food's spoilage reaction activation energy to track shelf-life loss
The activation energy of a Time-Temperature Indicator determines its sensitivity to temperature changes. To provide an accurate prediction of quality loss, the indicator's activation energy must closely match that of the specific chemical or microbiological spoilage reaction of the packaged food product, ensuring that the sensor's color change correlates with actual shelf-life depletion.

200. (D) To assemble items into a standardized load to ease handling and reduce transport costs
In industrial packaging logistics, unitization focuses on consolidating multiple smaller packages, such as individual retail cartons, into a single, standardized larger unit load like a palletized stack. This strategy greatly simplifies mechanical handling by forklifts, maximizes the efficiency of storage and shipping space, and reduces overall transport and labor costs during transit.

201. (B) 800 mm x 1200 mm or 1000 mm x 1200 mm standard footprint
Standard ISO pallet footprints, specifically measuring eight hundred by one thousand two hundred millimeters or one thousand by one thousand two hundred millimeters, are globally accepted dimensions designed to optimize shipping space. These standard sizes coordinate perfectly with the internal dimensions of standard ISO ocean containers, maximizing space utilization and reducing distribution costs.

202. (C) Interlocking improves stability against tipping, while columnar stacking maximizes strength
The selection of palletization stacking patterns represents a critical structural decision in logistics. Interlocking patterns, where cartons are rotated on successive layers, significantly improve physical stability against shifting and tipping during transit. Conversely, columnar patterns, where corners are aligned vertically, maximize the compressive load-bearing strength of the secondary packaging during storage.

203. (D) Modular packaging or dimensional coordination
Modular packaging, also referred to as dimensional coordination, is a logistical framework that standardizes the physical dimensions of primary and secondary packaging. This system ensures that small cartons assemble perfectly into larger containers with zero wasted space, which in turn fit precisely onto standard pallets for efficient loading into ISO shipping containers.

204. (A) Standard ISO dry containers provide hermetic sealing for modified atmosphere transport.
Standard dry cargo shipping containers are designed to protect goods from environmental weather, but they are not hermetically sealed and cannot hold modified atmosphere environments without specialized equipment. Thus, claiming they provide hermetic sealing for modified atmosphere transport is incorrect. Conversely, reefers regulate temperature, and twenty-foot equivalent units measure global shipping capacities.

205. (B) It significantly reduces compression strength, leading to potential load collapse
Allowing corrugated boxes to overhang the physical edge of a pallet represents a major defect in unit load design. Because corrugated

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2005

27. Which of the following statements is INCORRECT regarding the commercialization of functional dairy products?

(A) Regulatory approval processes can significantly delay product launches
(B) Sensory acceptability is irrelevant if the health benefit is proven
(C) Clinical validation adds to the development cost
(D) Premium pricing strategies are often utilized to recoup R&D investments

2015

28. How did the global COVID-19 pandemic structurally influence the dairy nutraceutical market?

(A) It increased consumer demand for immunity ingredients like lactoferrin
(B) It caused a structural and permanent shift away from all commercial immunity-boosting dairy products
(C) It severely and rapidly decreased the global consumer demand for ambient-stable functional milk
(D) It halted all active probiotic and prebiotic clinical research trials globally and indefinitely

2018

29. Which strategy is most effective for overcoming consumer skepticism toward health claims on dairy products?

(A) Utilizing complex chemical and biochemical nomenclature on the front-of-pack label
(B) Increasing the monosaccharide sugar content to mask highly undesirable artificial flavors
(C) Providing transparent, clinically backed substantiation
(D) Using highly ambiguous and scientifically unproven marketing terms such as miracle cure

2003

30. Which specific commercial challenge is uniquely associated with scaling up probiotic dairy food production?

(A) Completely removing all allergenic milk proteins and fractions from the dairy matrix
(B) Guaranteeing the finished commercial product requires absolutely zero refrigeration
(C) Synthesizing artificial lactose precursors chemically to feed the fermentative cultures
(D) Maintaining strain viability through processing and distribution

2003

31. What is the fundamental difference between the functional food markets of developed nations and emerging economies?

(A) Developed markets focus on basic nutrition, while emerging markets focus on hyper-specialized clinical nutrition
(B) Functional and nutraceutical food products are completely banned from distribution in emerging economies
(C) Emerging markets show high growth due to dietary transitions
(D) Developed nations rely almost exclusively on synthetic vitamin supplements rather than fortified food carriers

2021

32. Which of the following defines a bioactive peptide derived from milk proteins?

(A) A native intact macroprotein that provides solely dietary caloric energy and no other function
(B) An active peptide sequence released from a parent protein
(C) A synthetic chemical polymer chain added to commercial milk supplies during thermal processing
(D) A long-chain free fatty acid molecule responsible for developing characteristic milk flavor

2011

33. By what mechanism do ACE-inhibitory peptides from milk help manage hypertension?

(A) By significantly accelerating the heart rate to temporarily increase localized blood flow
(B) By directly and chemically dissolving solidified arterial cholesterol and lipid plaques
(C) By physiologically inducing the rapid and complete excretion of essential dietary calcium
(D) By blocking the conversion of angiotensin I to angiotensin II

2002

34. What is the specific enzymatic process required to release casokinins from intact casein micelles?

(A) Proteolytic hydrolysis via pepsin or trypsin
(B) High-pressure physical homogenization of fluid milk
(C) Intensive thermal pasteurization under dry heat conditions
(D) High-speed centrifugal mechanical phase separation

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(A) They are synthesized abundantly de novo within the body
(B) They exhibit extremely strong and clinically proven anti-inflammatory properties
(C) They remain highly and uniquely susceptible to structural lipid peroxidation
(D) They play a highly critical, protective role in maintaining cardiovascular health

2010

53. How does vaccenic acid biologically function in humans after consumption?
(A) It acts strictly as an inert, non-caloric physical filler within the human digestive system
(B) It aggressively and systematically promotes the rapid formation of dense arterial plaques
(C) It completely and irreversibly blocks the standard physiological absorption of dietary calcium
(D) It acts as a precursor, endogenously converting to CLA

2021

54. What is the defining antimicrobial mechanism of bovine lactoferrin?
(A) Direct and rapid enzymatic lysis of structurally intact Gram-positive bacterial peptidoglycan walls
(B) Chelation of free iron, depriving bacteria of nutrients
(C) Complete and competitive biological exclusion of pathogens by binding tightly to host intestinal villi
(D) Systemic neutralization of highly acidic gastric stomach acid secretions to prevent bacterial survival

2013

55. Given the assertion (A) and reason (R), choose the correct option.
Assertion (A): The lactoperoxidase system can be intentionally activated to extend the shelf life of raw milk in areas lacking refrigeration.
Reason (R): Lactoperoxidase directly denatures all milk proteins at ambient temperatures to prevent bacterial growth.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2022

56. Which three components are required to activate the lactoperoxidase antimicrobial system in milk?
(A) Lactoferrin proteins, divalent zinc, and ascorbic acid
(B) Bovine immunoglobulins, organic urea, and simple lactose
(C) Purified lysozyme, calcium salts, and inorganic phosphate
(D) Lactoperoxidase, peroxide, and thiocyanate

2003

57. Which of the following statements is INCORRECT regarding bovine milk immunoglobulins?
(A) They easily survive ultra-high temperature processing
(B) IgG is the single predominant, highly concentrated class of immunoglobulin found in bovine colostrum
(C) They confer crucial maternal passive systemic immunity directly to the vulnerable newborn calf
(D) They can bind highly specifically to target pathogenic microorganisms in the human gastrointestinal tract

NODIA

2025

58. What is the primary physiological function of Bovine Milk Oligosaccharides (BMOs) when consumed?
(A) They act as an immediate and major metabolic cellular energy source for host nervous brain tissues
(B) They serve as prebiotics, stimulating gut bifidobacteria
(C) They directly and rapidly mineralize skeletal bone tissue via localized calcium deposition
(D) They systematically inhibit the endogenous synthesis and secretion of host active digestive enzymes

2018

59. Which minor milk protein exhibits direct muramidase activity, specifically cleaving the cell walls of Gram-positive bacteria?
(A) Beta-lactoglobulin
(B) Lysozyme
(C) Alpha-lactalbumin
(D) Osteopontin

2014

60. Consider the following statements regarding the isolation of minor functional milk components:
I. Lactoferrin is typically isolated using cation exchange chromatography.

2003

44. What defines the structural backbone of sphingolipids found in the milk fat globule membrane (MFGM)?
(A) A sphingosine base
(B) A glycerol molecule
(C) A cholesterol ring
(D) A short-chain fatty acid

2013

45. Which feeding strategy effectively enriches bovine milk with omega-3 polyunsaturated fatty acids?
(A) Feeding lactating cows a strictly grain-based, high-starch concentrate ration
(B) Completely restricting all fresh green pasture forage from the daily animal diet
(C) Supplementing diets with extruded flaxseed or algae
(D) Providing excessive industrial quantities of highly saturated animal tallow in the feed

2006

46. What is the primary biochemical mechanism by which rumen bacteria produce CLA?
(A) De novo biosynthetic synthesis utilizing low-molecular precursors like acetate and butyrate
(B) Rapid and uncontrolled oxidative degradation of palmitic acid in the ruminal fluid
(C) Thermal polymerization of long-chain saturated free fatty acids under standard conditions
(D) Incomplete biohydrogenation of dietary unsaturated fatty acids

2017

47. Which of the following statements is correct regarding the health implications of dietary sphingomyelin from milk?
(A) It is highly and directly associated with the rapid cellular promotion of human colorectal cancer
(B) It permanently and irreversibly blocks the absorption of essential fat-soluble vitamins in the intestine
(C) It serves as a structural component in brain development
(D) It rapidly degrades into highly toxic free radicals and lipid peroxides during standard human digestion

2016

48. Which of the following represents an INCORRECT consequence of enriching milk with high levels of omega-3 fatty acids?
(A) Increased susceptibility of the milk to oxidative rancidity
(B) A significant extension of the milk's ambient shelf life without antioxidants
(C) Alteration of the milk's solid fat content and butter spreadability
(D) Potential development of off-flavors (fishy notes) if not properly masked or encapsulated

2022

49. What is the cause of the naturally higher concentration of CLA in milk from pasture-fed cows compared to stall-fed cows?
(A) Pasture-fed dairy cows produce significantly less total milk fat output over their entire lactation cycle
(B) Stall-fed cows lack the critical hepatic enzymes required for any active de novo fatty acid synthesis pathways
(C) Direct solar radiation onto the grazing animal directly converts milk cholesterol molecules into active CLA
(D) Pasture grasses contain alpha-linolenic acid, a CLA precursor

2004

50. Which class of functional milk lipids is clinically researched for its potential to inhibit adipogenesis and manage body composition?
(A) Conjugated Linoleic Acid
(B) Short-chain triglyceride molecules
(C) Cholesterol ester fractions
(D) Squalene hydrocarbon lipid

2011

51. What is the primary function of the Milk Fat Globule Membrane (MFGM) in raw milk?
(A) To act as a selective physical reservoir for fully water-soluble B-complex vitamins
(B) To rapidly and enzymatically hydrolyze complex triglycerides into free fatty acid chains
(C) To stabilize lipid droplets in milk and prevent coalescence
(D) To chemically precipitate intact casein micelles during specialized analytical isoelectric focusing

2011

52. Among the following, which is NOT a characteristic of functional dairy omega-3 fatty acids like EPA and DHA?

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2014

83. Which of the following acts as the most significant challenge when formulating synbiotic yogurts with high dosages of prebiotics?
(A) The total and irreversible physical separation and loss of all emulsified milk fat from the matrix
(B) Immediate chemical conversion of the liquid product into a highly solidified, unpalatable plastic-like mass
(C) Excessive gas production altering texture and causing discomfort
(D) Complete metabolic suppression of the initial lactic acid starter culture fermentation during yogurt processing

2009

84. Which of the following compounds is generally considered an exception and NOT classified as a standard recognized prebiotic?
(A) Aspartame
(B) Xylooligosaccharides (XOS)
(C) Trans-galactooligosaccharides (TOS)
(D) Pectin

2015

85. Which of the following represents the correct processing order for integrating functional botanical extracts into a pasteurized dairy beverage?
I. Homogenization of the mixture
II. Extraction of active phytochemicals from the herb
III. Thermal pasteurization
IV. Blending the extract into the raw milk matrix
(A) II → IV → I → III
(B) IV → II → III → I
(C) II → I → IV → III
(D) I → II → IV → III

2011

86. How is a phytochemical precisely defined in the context of functional food formulation?
(A) An animal-derived dietary macroprotein strictly required for skeletal muscle protein synthesis
(B) An active, non-nutrient plant compound conferring benefits
(C) A synthetic coal-tar derived chemical dye compound used strictly for intense artificial food coloring
(D) A highly toxic heavy metal element naturally and abundantly occurring within the agricultural soil

2013

87. What is the primary technical challenge when incorporating curcumin (from turmeric) into an aqueous milk beverage?
(A) Curcumin's extreme water solubility causes too rapid a color shift
(B) Curcumin immediately coagulates all milk proteins upon contact
(C) Curcumin's inherent lipophilicity and poor aqueous solubility
(D) Curcumin vaporizes completely during cold storage

NODIA

2013

88. Which of the following statements is INCORRECT regarding the integration of botanicals in fusion dairy matrices?
(A) Polyphenols from tea can strongly interact with milk caseins, altering antioxidant bioavailability
(B) The addition of strong herbal extracts often necessitates flavor-masking techniques
(C) Heat treatment during dairy processing can degrade volatile phytochemicals
(D) Botanical integration uniformly extends the shelf-life of dairy products without exception

2009

89. Which specific active component is primarily responsible for the adaptogenic properties of Ashwagandha (Withania somnifera) used in therapeutic milk?
(A) Withanolides
(B) Curcuminoids
(C) Ginsenosides
(D) Catechins

2013

90. Consider the following statements regarding ingredient-matrix interactions in herbal dairy foods:
I. Milk fat can protect lipophilic bioactive compounds during digestion.
II. Milk proteins strictly inhibit all phytochemical absorption in the human gut.
III. Phenolic compounds can induce astringency in the dairy product.
IV. Encapsulation completely destroys the bioactivity of essential oils.
Which of the above statements are INCORRECT?
(A) I and III
(B) II and IV
(C) Only II
(D) III and IV

II. BMOs are highly concentrated in late lactation mature milk.
III. Colostrum is the most viable commercial source for extracting bovine immunoglobulins.
IV. Lactoperoxidase is primarily a lipid-based molecule.

Which of the above statements are correct?
(A) I and III
(B) II and IV
(C) I, II, and III
(D) Only III

2018

61. How does the structural complexity of Bovine Milk Oligosaccharides (BMOs) compare to Human Milk Oligosaccharides (HMOs)?
(A) BMOs are structurally and biochemically identical to HMOs in every functional aspect
(B) BMOs contain exclusively highly branched fucosylated structures not found in humans
(C) BMOs have lower structural diversity and concentration than HMOs
(D) BMOs are entirely composed of highly polymerized pure linear glucose starch chains

2005

62. What is the primary cause of activity loss in functional immunoglobulins during standard commercial milk powder production?
(A) The physical and high-pressure shearing forces generated inside the homogenization valve
(B) The uncontrolled chemical crystallization of lactose molecules during the evaporator phase
(C) The rapid and extreme cooling phase implemented during standard commercial pasteurization runs
(D) Thermal load during spray drying causing denaturation

2003

63. Which of the following represents an exception to the general biological activities of lactoferrin?
(A) Antiviral biological properties
(B) Active bone growth stimulation
(C) Emulsification of lipids
(D) Systemic immune modulation

2019

64. What qualifies a microorganism as a probiotic under standard definitions?
(A) Any dead or inactive bacterial cell structures present inside traditionally fermented foods
(B) Live microorganisms conferring a health benefit in adequate amounts
(C) Fungal mold spores that directly cause the rapid microbiological spoilage of dairy matrices
(D) Synthetic biochemical enzymes designed specifically to accelerate physiological gastric emptying

2019

65. Which of the following is a key physiological criterion for the selection of a commercial probiotic strain?
(A) Ability to rapidly produce biogenic amines
(B) Extreme sensitivity to stomach acid to prevent colonization
(C) Obligate requirement for highly aerobic environments
(D) Resistance to human gastric acidity and bile toxicity

2024

66. Which of the following statements is INCORRECT concerning the genus Bifidobacterium in probiotic dairy foods?
(A) They are strictly aerobic organisms thriving in high oxygen environments
(B) They are predominant early colonizers of the breastfed infant gut
(C) They commonly utilize oligosaccharides as a primary fermentation substrate
(D) Their morphological appearance is often Y-shaped or branched

2017

67. What is the standard minimum viable count of probiotic bacteria generally required in a dairy product at the end of its shelf life to justify a health claim?
(A) 10^{1} to 10^{2} CFU/g
(B) 10^{2} to 10^{3} CFU/g
(C) 10^{6} to 10^{7} CFU/g
(D) $10^{\{10\}}$ to $10^{\{12\}}$ CFU/g

2023

68. How does over-acidification (post-acidification) during the refrigerated storage of probiotic yogurt specifically affect the product?
(A) It leads to loss of viable probiotic counts and excessive sourness
(B) It dramatically and systematically increases the long-term viability of sensitive Bifidobacterium strains
(C) It biochemically converts simple milk lactose directly into complex, completely neutral lipids

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2025

35. Which of the following correctly pairs a milk protein fraction with its derived bioactive peptide?
(A) Alpha-lactalbumin — Casomorphin peptide fraction
(B) Beta-casein — Lactokinin derived fragment
(C) Kappa-casein — GMP
(D) Beta-lactoglobulin — Lactoferricin sequence

2012

36. Which of the following statements INCORRECTLY characterizes the immunomodulatory mechanisms of whey-derived peptides?
(A) They suppress the immune system entirely
(B) They can stimulate the cell-mediated proliferation of lymphocytes
(C) They may enhance the active phagocytosis processes by host macrophages
(D) They regulate the systemic secretion of various inflammatory cytokines

2004

37. Which of the following peptides is specifically known for its opioid-like agonist activity?
(A) Lactokinin
(B) Lactoferricin B
(C) Caseinophosphopeptide
(D) Beta-casomorphin

2008

38. What is the functional role of caseinophosphopeptides (CPPs) in human nutrition?
(A) They act as highly potent competitive inhibitors of intestinal lactose enzymes
(B) They bind minerals like calcium, enhancing absorption
(C) They exclusively and aggressively trigger systemic food allergic reactions in human adults
(D) They rapidly and completely degrade essential unsaturated fatty acids within the small gut

2015

39. Which sequence best represents the in vivo generation of bioactive peptides from milk consumption?
(A) Intestinal absorption → Gastric hydrolysis → Pancreatic digestion → Systemic circulation
(B) Systemic circulation → Pancreatic digestion → Gastric hydrolysis → Intestinal absorption
(C) Gastric hydrolysis → Pancreatic digestion → Intestinal absorption → Systemic circulation
(D) Pancreatic digestion → Intestinal absorption → Systemic circulation → Gastric hydrolysis

2012

40. Consider the following statements regarding milk-derived bioactive peptides:
I. They remain totally inactive while encysted within the parent protein sequence.
II. They can only be generated through bacterial fermentation, not digestive enzymes.
III. They usually range from 2 to 20 amino acids in length.
IV. They are highly susceptible to severe thermal degradation.
Which of the above statements are incorrect?
(A) I and III
(B) II and IV
(C) Only II
(D) III and IV

2021

41. Which of the following is NOT considered a proven physiological activity of whey-derived bioactive peptides?
(A) Cholesterol synthesis
(B) Broad-spectrum antimicrobial activity
(C) Physiological satiety induction
(D) In vitro antioxidant capability

2007

42. How does the structure of lactoferricin differ fundamentally from intact lactoferrin?
(A) Lactoferricin is classified strictly as a lipid, whereas lactoferrin is structured as a complex carbohydrate
(B) Lactoferricin is a peptide cleaved from intact lactoferrin
(C) Lactoferricin represents the high-molecular polymerized quaternary structural form of native lactoferrin
(D) Lactoferricin requires divalent zinc cofactors to function, unlike standard iron-binding lactoferrin molecules

NODIA

2010

43. Which specific isomer of Conjugated Linoleic Acid (CLA) is most abundantly found in ruminant milk fat?
(A) trans-10, cis-12 CLA
(B) cis-9, trans-11 CLA
(C) cis-11, trans-13 CLA
(D) trans-9, trans-11 CLA

2009

76. Which structural characteristic defines inulin, a prominent dietary prebiotic?

(A) A polymer of fructofuranosyl units terminating in a glucose

(B) A linear polymer structure composed of multiple glucose monosaccharide units linked by standard alpha-1,4 bonds

(C) A highly complex, heterogeneous lipid blend composed primarily of highly saturated, long-chain free fatty acids

(D) A highly branched and folded polypeptide chain containing exclusively essential L-configuration amino acids

2004

77. How are Galactooligosaccharides (GOS) commercially produced for use in prebiotic dairy applications?

(A) By utilizing direct, high-temperature hot water and acidic extraction protocols on harvested chicory roots

(B) Through the complete, irreversible high-heat thermal denaturing degradation of native sweet whey proteins

(C) Through transgalactosylation of lactose by beta-galactosidase

(D) By the purely inorganic chemical synthesis of simple galactose and sucrose molecules under extreme high pressure

2008

78. What specific functional phenomenon describes the concept of a synbiotic dairy product?

(A) The absolute and complete physical antagonistic exclusion of target live probiotic strains by added dietary plant fiber

(B) The de novo chemical synthesis of entirely new lipid-soluble vitamin complexes within a completely sterile food matrix

(C) The industrial, simultaneous mechanical removal of all carbohydrate and lipid fractions from fluid bovine skim milk

(D) A blend of probiotic and prebiotic enhancing survival and colonization

2008

79. Which of the following statements is INCORRECT regarding the application of Fructooligosaccharides (FOS) in fermented milks?

(A) They possess mild sweetening properties

(B) They can improve the texture and mouthfeel of low-fat yogurts

(C) They increase only the product's caloric density

(D) They selectively promote the growth of Bifidobacterium species

2016

80. Match the prebiotic compounds in List I with their primary commercial source in List II.

List I: (Prebiotic compounds)

P. Inulin

Q. Galactooligosaccharides (GOS)

R. Lactulose

S. Fructooligosaccharides (FOS)

List II: (Primary commercial source)

1. Enzymatic conversion of lactose
2. Isomerization of lactose
3. Chicory root extraction
4. Enzymatic hydrolysis of inulin or synthesis from sucrose

(A) P-3, Q-1, R-2, S-4

(B) P-4, Q-2, R-1, S-3

(C) P-3, Q-2, R-1, S-4

(D) P-1, Q-4, R-3, S-2

2010

81. What is the direct cause of increased calcium absorption associated with prebiotic consumption?

(A) The added prebiotic molecules directly chelate calcium ions, physically transporting them across the whole mucosal epithelium

(B) Prebiotics genetically mutate host mucosal enterocytes to permanently open up passive voltage-gated calcium channels

(C) Prebiotics systematically and completely inhibit the parietal cell production of hydrochloric gastric acid in the stomach

(D) Prebiotic fermentation yields SCFAs, lowering pH and dissolving calcium

2001

82. Which of the following correctly compares the Degree of Polymerization (DP) of standard inulin to short-chain FOS?

(A) Inulin has a higher DP, providing more texturizing properties

(B) Inulin structurally possesses a significantly lower average DP value compared directly to synthetic short-chain FOS

(C) Both of these active prebiotic carbohydrate compounds possess absolutely identical molecular DP ranges in nature

(D) The average Degree of Polymerization is entirely irrelevant to the physiological and physical functionality of fructans

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(C) Calcium fortification always increases the bioavailability of co-ingested iron
(D) Stabilizers like carrageenan are often needed to suspend insoluble calcium salts

2011
100. Match the micronutrients in List I with their primary processing or formulation challenges in milk in List II.

List I: (Micronutrient)
P. Vitamin A
Q. Iron
R. Vitamin C
S. Calcium

List II: (Processing or formulation challenge)
1. Extreme thermal instability during pasteurization/UHT
2. Precipitation and protein destabilization
3. Susceptibility to photo-oxidation in clear packaging
4. Catalysis of lipid oxidation and metallic off-flavors

(A) P-3, Q-4, R-1, S-2
(B) P-4, Q-3, R-2, S-1
(C) P-1, Q-2, R-3, S-4
(D) P-2, Q-1, R-4, S-3

2004
101. What is the direct physiological effect of fortifying dairy products with Vitamin D alongside calcium?
(A) Vitamin D biologically inhibits the active intestinal cellular transport of calcium ions
(B) Vitamin D chemically precipitates dietary calcium in the stomach, completely preventing any absorption
(C) Vitamin D directly converts soluble dietary calcium into structural bone marrow almost instantly
(D) Vitamin D enhances active transport of calcium in enterocytes

2009
102. Which of the following correctly pairs a micronutrient with its common chemical form used for milk fortification?
(A) Iron — Ferric chloride
(B) Vitamin A — Retinyl palmitate
(C) Vitamin D — Calciferol-sulfate
(D) Calcium — Calcium hypochlorite

2023
103. Which of the following statements is INCORRECT regarding the stability of vitamins used in milk fortification?
(A) Vitamin A is highly light-sensitive and chemically unstable in liquid media
(B) Riboflavin rapidly degrades under standard environmental ultraviolet (UV) light
(C) Vitamin D is highly volatile and rapidly lost during standard refrigeration
(D) Ascorbic acid is easily destroyed by industrial thermal treatments and dissolved oxygen

2014
104. In comparing fortification technologies, why is microencapsulated iron preferred over free ferrous sulfate in fortified milk powders?
(A) It dramatically and systematically increases the strong metallic taste profile, making the final milk robust
(B) It rapidly turns the processed milk powder a highly desirable, deep dark brown aesthetic color
(C) It biochemically makes the iron nutrient entirely and completely unavailable for normal human gut absorption
(D) It prevents iron from interacting with lipids and proteins

2014
105. Which of the following represents the correct processing arrangement for standard liquid milk fortification?
I. Flash pasteurization
II. Standardizing fat and SNF
III. Addition of vitamin premix to the standardized milk
IV. Homogenization
(A) I → II → III → IV
(B) II → III → IV → I
(C) III → I → II → IV
(D) II → IV → I → III

2016
106. What is the primary biochemical objective in the humanization of bovine milk for infant formula formulation?
(A) Adding genetically cloned human cellular DNA fragments directly into the raw bovine milk matrix
(B) Modifying milk's nutrient profile to match human breast milk
(C) Completely removing all dairy proteins and replacing them with highly refined plant-derived starches
(D) Increasing the overall sodium mineral content to match adult-level physiological and metabolic needs

NODIA

2014

91. What is the specific biochemical effect of polyphenol-protein interactions in a dairy matrix?
(A) They cause the rapid, instantaneous enzymatic conversion of native milk lactose into glucose and galactose
(B) They form insoluble complexes, potentially reducing antioxidant capacity
(C) They dramatically and directly increase the physical vapor pressure of fluid milk at room temperature
(D) They synthetically produce entirely new essential and non-essential amino acids de novo in the fluid matrix

2006

92. Which technological process is most appropriately used to mask the intense, bitter flavor profile of certain therapeutic herbs in dairy formulations?
(A) Encapsulation of the botanical extract prior to blending
(B) Simple sensory addition of massive, unpalatable industrial quantities of sodium chloride salts
(C) Complete, multi-stage mechanical removal of all milk fat fractions from the processed liquid
(D) Boiling the raw milk continuously under high atmospheric pressure for twenty-four hours straight

2012

93. Which of the following botanicals is least commonly integrated into commercial fusion dairy health foods due to extreme toxicity or lack of regulatory approval?
(A) Tulsi herbal extract
(B) Brahmi botanical species
(C) Belladonna
(D) Turmeric rhizome powder

2015

94. In the classification of phytochemicals commonly used in dairy fusions, catechins and anthocyanins belong to which broad category?
(A) Alkaloids
(B) Terpenes
(C) Organosulfur compounds
(D) Flavonoids

2001

95. Given the assertion (A) and reason (R), choose the correct option.
Assertion (A): Adding iron salts to liquid milk can significantly accelerate the development of oxidized off-flavors.
Reason (R): Iron acts as a potent pro-oxidant catalyst for the auto-oxidation of unsaturated milk lipids.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

NODIA

2025

96. How is the principle of fortification technically distinguished from enrichment in dairy processing?
(A) Enrichment constitutes the physical removal of excess fat globules, whereas fortification represents adding pure water
(B) Fortification adds new nutrients; enrichment restores lost nutrients
(C) Fortification applies exclusively to structural macronutrients, whereas enrichment applies solely to trace vitamins
(D) There is absolutely and legally no scientific, regulatory, or technical difference between these two industry terms

2014

97. What is the mandated source for fortifying milk with Vitamin D under standard food safety regulations?
(A) Beta-carotene carotenoid pigments
(B) Ascorbic acid antioxidant crystals
(C) Retinyl acetate vitamin formulation
(D) Cholecalciferol

2024

98. Which specific form of iron fortificant causes the least oxidative degradation and color change in dairy products, though it has lower bioavailability?
(A) Ferric pyrophosphate
(B) Ferrous sulfate crystals
(C) Ferrous gluconate solution
(D) Ferrous ascorbate complex

2016

99. Which of the following statements is INCORRECT regarding calcium fortification of milk?
(A) Highly soluble calcium salts like calcium chloride can destabilize casein micelles leading to heat coagulation
(B) Tricalcium phosphate is frequently used because it causes minimal destabilization

(D) It completely and permanently halts all forms of physical syneresis inside the set yogurt gel structure

2005

69. Which technological intervention is most effectively used to protect probiotic viability against harsh gastric environments and processing stress?
(A) Exposing the active bacterial cells to intense, short-wave ultraviolet radiation prior to product inoculation
(B) Culturing the selective probiotic strains in a completely synthetic, nutrient-depleted fermentation medium
(C) Increasing the industrial homogenization pressure specifically to rupture the bacterial cellular walls
(D) Microencapsulation of cells within biopolymer matrices like alginate

2012

70. Consider the following statements regarding probiotic health claims:
I. Claims can guarantee the absolute prevention of infectious diseases.
II. Claims must be substantiated by robust, strain-specific human clinical trials.
III. Probiotics generally help in alleviating symptoms of lactose intolerance.
Which of the above statements are correct?
(A) I and II
(B) Only I
(C) II and III
(D) I and III

2018

71. Given the assertion (A) and reason (R), choose the correct option.
Assertion (A): Lactobacillus acidophilus is frequently utilized in commercial probiotic milk formulations.
Reason (R): It naturally possesses strong intrinsic resistance to host bile salts and gastric pH.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2024

72. Which of the following is NOT a recognized mechanism of action for probiotic bacteria in the gut?
(A) Production of antimicrobial substances like bacteriocins
(B) Enhancement of the intestinal epithelial barrier integrity
(C) Competitive adhesion to the intestinal mucosa blocking pathogens
(D) Direct destruction of host enterocytes to access blood nutrients

2017

73. What is the physiological purpose of incorporating a specific probiotic strain to target antibiotic-associated diarrhea (AAD)?
(A) To restore native gut microbiota disturbed by the antibiotic
(B) To act synergistically with the administered antibiotic formulation to actively kill host healthy tissues
(C) To permanently and irreversibly alter the host cellular genomic DNA expression profiles over time
(D) To significantly increase the metabolic absorption rate of the active antibiotic compound in the stomach

2017

74. Why is a fermented dairy matrix like yogurt considered an optimal delivery vehicle for probiotics?
(A) Yogurt fermentation inherently and completely destroys all external bacterial cellular structures before ingestion
(B) Milk proteins provide buffering shielding probiotics during transit
(C) The abnormally high dissolved oxygen content of commercial yogurt significantly accelerates probiotic cellular metabolism
(D) The extremely low pH of the yogurt matrix guarantees an absolute, infinite biological shelf life for the active bacteria

2006

75. Which of the following criteria must a substance meet to be classified as a prebiotic?
(A) It must exist primarily as an intact, fully live and replication-competent bacterial cell
(B) It must resist host digestion and stimulate beneficial gut bacteria
(C) It must be completely and rapidly hydrolyzed by host salivary amylase enzymes upon oral intake
(D) It must exhibit highly potent, systemic broad-spectrum chemical antibiotic properties in the host

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2003

107. Which precise ratio of whey proteins to caseins is targeted in standard stage 1 infant formulas to mimic mature human milk?
(A) 10:90
(B) 20:80
(C) 60:40
(D) 80:20

2009

108. Why is cow's milk highly unsuitable for direct consumption by human neonates without formulation adjustments?
(A) It has a high renal solute load and lacks essential fatty acids
(B) It has a critical and severe deficiency in overall macroprotein concentration and biological value
(C) It completely lacks any physiological form of essential divalent calcium or inorganic phosphorus
(D) It naturally contains a highly toxic level of extremely complex human milk prebiotic oligosaccharides

2022

109. Which specific essential amino acid is commonly added to infant formulas because bovine whey protein is naturally deficient in it compared to human milk?
(A) Glycine amino acid
(B) Glutamine compound
(C) Tryptophan
(D) Proline precursor

2025

110. Consider the following statements regarding infant formula legislation and standards:
I. Regulatory standards strictly prohibit the addition of artificial colors to infant formula.
II. Standards mandate a minimum and maximum limit for energy density.
III. Infant formulas must have zero carbohydrates to prevent early tooth decay.
IV. Iron fortification is regulated to prevent iron-deficiency anemia in infants.
V. The inclusion of pathogenic bacteria is heavily regulated but allowed up to 10^2 CFU/g.
Which of the above statements are correct?
(A) I, II, and III
(B) I, II, and IV
(C) II, IV, and V
(D) III, IV, and V

2006

111. How does the application of electrodialysis benefit the production of demineralized whey used in infant formulas?
(A) It permanently and irreversibly denatures native whey proteins to significantly reduce overall formula allergenicity
(B) It biologically synthesizes complex, long-chain polyunsaturated fatty acids utilizing simple lactose molecules as precursors
(C) It removes minerals like sodium and potassium to lower renal solute load
(D) It physically sterilizes the finished formula powder by passing high-voltage electricity through the dry product lines

2006

112. Which of the following statements is INCORRECT regarding lipid modification in infant formula development?
(A) Bovine milk fat is regularly and completely replaced with a balanced commercial blend of vegetable oils
(B) The modification is performed to mimic the fatty acid profile of raw cow's milk
(C) Long-chain polyunsaturated arachidonic acid (ARA) and docosahexaenoic acid (DHA) are frequently supplemented
(D) Emulsifiers like lecithin are utilized to stabilize the substituted fat blend

2019

113. What physiological consequence arises if an infant formula possesses an excessively high renal solute load?
(A) The developing infant will immediately develop extremely and pathologically low arterial blood pressure
(B) The infant digestive tract will process and digest complex proteins at least twice as fast as normal
(C) The prepared liquid formula will ferment spontaneously and rapidly inside the feeding bottle environment
(D) The kidneys must excrete large volumes of water, risking dehydration

2005

114. Which specific protein fraction is technologically enriched in premium infant formulas because it is a dominant protein in human milk?
(A) Alpha-lactalbumin
(B) Beta-lactoglobulin
(C) Gamma-casein
(D) Bovine serum albumin

NODIA

2009

115. In classifying infant formulas, what distinguishes a hypoallergenic or hydrolyzed formula from standard formula?
(A) All simple milk lactose has been chemically and completely replaced with highly refined pure sucrose sugars
(B) The formulated milk is completely and absolutely devoid of any lipid or essential fatty acid fat content
(C) The proteins are enzymatically cleaved into smaller peptides
(D) The final prepared liquid formula utilizes exclusively intact and unhydrolyzed bovine casein micelles

2019

116. Which of the following ingredients is legally restricted or forbidden from inclusion in standard infant formulas under Codex guidelines?
(A) Artificial non-nutritive sweeteners
(B) Synthetic alpha-tocopherol vitamins
(C) Exogenous dietary nucleotide compounds
(D) Supplemental free L-carnitine isomers

2005

117. What specifically defines a "weaning food" in pediatric nutrition?
(A) A specialized liquid formula designed to replace colostrum in the first week of life
(B) A textured solid food used to soothe crying infants and develop early jaw strength
(C) A transitional food introduced when milk is no longer sufficient for nutritional needs
(D) A sugar-sweetened beverage supplemented with synthetic vitamins for active toddlers

2009

118. Which specific processing technique is widely applied to cereal-dairy weaning foods to fundamentally reduce dietary bulk and starch viscosity?
(A) Amylase-rich flour addition or malting
(B) Cryogenic freezing of raw materials
(C) Organic solvent total lipid extraction
(D) High-heat anaerobic lactic fermentation

2014

119. How does extrusion cooking technologically improve the nutritional profile of dairy-cereal complementary foods?
(A) By increasing the total crude fiber and ash content
(B) By raising the final moisture content to facilitate liquid feeding
(C) By converting lipids into complex water-soluble starches
(D) By gelatinizing starches and reducing anti-nutritional factors

2019

120. Identify the INCORRECT statement regarding the formulation of complementary weaning foods.
(A) They must be nutrient-dense to accommodate the infant's small gastric capacity
(B) High levels of raw, intact dietary fiber are highly recommended to prevent infant diarrhea
(C) The inclusion of milk powder improves the overall protein quality and amino acid score
(D) They should have a soft, easily swallowable texture when reconstituted

2009

121. What is the direct cause of the Maillard browning reaction occurring heavily during the drum drying of milk-cereal weaning blends?
(A) The enzymatic oxidation of phenolic compounds under mild conditions
(B) The rapid crystallization of milk lipids during cooling cycles
(C) The thermal reaction of reducing sugars with free amino groups
(D) The heat-induced degradation of unstable synthetic vitamins

2009

122. Match the weaning food processing parameter listed in List I with its intended physical or nutritional outcome listed in List II:

List I: Processing Parameter
P. High-shear extrusion
Q. Protease addition
R. Malting of cereals
S. Roller/Drum drying

List II: Physical/Nutritional Outcome
1. Pre-digestion of proteins for easier assimilation
2. Starch gelatinization and texturization
3. Instantization and flake formation
4. Activation of endogenous amylases to reduce viscosity

(A) P-3, Q-4, R-2, S-1
(B) P-1, Q-2, R-3, S-4
(C) P-4, Q-3, R-1, S-2
(D) P-2, Q-1, R-4, S-3

2023

123. When comparing processing techniques, what is the primary advantage of twin-screw extrusion

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over single-screw extrusion for dairy-cereal blends?
(A) Twin-screw extruders offer superior mixing, control, and moisture versatility
(B) Twin-screw extruders have much lower capital investment and operational costs
(C) Twin-screw extruders operate exclusively with dry, zero-moisture food matrices
(D) Twin-screw extruders rely solely on external heaters without friction generation

2024
124. Which pairing correctly identifies a key ingredient in weaning foods and its primary physiological function?
(A) Raw wheat bran — Supply of rapid, highly digestible dietary carbohydrates
(B) Skim milk powder — Supply of high biological value protein and calcium
(C) High fructose corn syrup — Prevention of metabolic disorders and diabetes
(D) Unprocessed soy flour — Increase of endogenous trypsin inhibitor activity

2024
125. Which of the following is NOT a standard safety or quality requirement for dairy-cereal weaning foods?
(A) Maintaining low total microbial and pathogen counts
(B) Incorporating Clostridium botulinum spores to build early immunity
(C) Ensuring complete absence of heavy metal residues and aflatoxins
(D) Ensuring easy and rapid reconstitution in warm potable water

2019
126. What defines the specific nutritional rationale for blending dairy proteins with cereal proteins in complementary foods?
(A) To achieve amino acid complementarity where milk lysine balances deficient cereals
(B) To lower formulation costs by blending milk proteins with inexpensive bulk fillers
(C) To formulate a final product that is devoid of any sulfur-containing amino acids
(D) To raise the overall glycemic index of the carbohydrate matrix in the product

2021
127. Which class of complementary food is specifically formulated by mechanically blending pre-cooked, dried milk and toasted cereal flours without further thermal processing?
(A) Extruded ready-to-eat puffs
(B) Retort processed wet purees
(C) Dry blended instant infant cereals
(D) Fermented alcoholic gruels

2003
128. What precise definition applies to the term "sarcopenia" which geriatric dairy foods aim to mitigate?
(A) The abnormal, chronic thickening of the gastric lining in elderly patients
(B) The permanent loss of the physiological ability to hydrolyze milk lactose
(C) The systemic, accelerated hyper-calcification of arterial wall tissues
(D) The age-related, progressive loss of skeletal muscle mass and function

2002
129. Identify the correct physiological reason why specific nutritional requirements for high-quality protein are elevated in the geriatric population.
(A) Elderly individuals maintain an elevated basal metabolic rate that demands large daily caloric intake
(B) They must continually replace high amounts of body proteins lost exclusively through heavy daily sweating
(C) Elderly individuals experience "anabolic resistance," requiring a higher per-meal protein dose to stimulate muscle protein synthesis
(D) Dietary proteins are biochemically converted directly into inorganic bone minerals in senior citizens

2018
130. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): Geriatric dairy formulations frequently include added dietary fiber and prebiotics.
Reason (R): The elderly commonly suffer from decreased intestinal motility and altered gut microbiota.
(A) Both (A) and (R) are true and (R) is the correct explanation of (A).
(B) Both (A) and (R) are true but (R) is not the correct explanation of (A).
(C) (A) is true but (R) is false.
(D) (A) is false but (R) is true.

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2005
131. Which of the following is an INCORRECT assumption regarding geriatric dairy product formulation?
(A) Products should ideally have a soft texture to accommodate poor dentition or dysphagia
(B) Fortification with Vitamin B_{12} is beneficial due to reduced intrinsic factor secretion
(C) Caloric density may need to be concentrated due to reduced appetite in the elderly
(D) High-fat, high-sodium cheeses are optimal for general geriatric daily nutrition

2023
132. How does the deliberate enhancement of digestibility in geriatric dairy foods biochemically assist the elderly consumer?
(A) By compensating for reduced gastric acid and lower pancreatic enzyme secretion
(B) By completely bypassing the stomach to allow direct absorption through the esophagus
(C) By slowing down the digestive tract to a complete halt to maintain satiety for days
(D) By fermenting proteins directly within the small intestine to generate active alcohol

2010
133. Consider the following statements regarding bone-health fortification in geriatric dairy foods:
I. Calcium must be combined with Vitamin D for optimal bone matrix incorporation.
II. Vitamin K2 is increasingly added to direct calcium to the bones and away from arteries.
III. High phosphorus levels strictly inhibit all calcium absorption permanently.
IV. Phytoestrogens can be added to support bone density in postmenopausal women.
V. Complete removal of dairy proteins is required to prevent bone leaching.
Which of the above statements are correct?
(A) II, III, and V
(B) I, III, and IV
(C) I, II, and IV
(D) I, II, and V

2002
134. Which specific formulation parameter is primarily modified to address dysphagia (swallowing difficulty) in clinical geriatric dairy foods?
(A) The rheological properties and fluid viscosity
(B) The sensory color intensity and visual appearance
(C) The precise sodium to potassium mineral ratio
(D) The chemical class of artificial sweetener used

2022
135. Which nutrient is generally NOT recommended for significant supplementation in standard geriatric dairy formulations due to hypertension risks?
(A) Calcium
(B) Vitamin D
(C) Whey protein
(D) Sodium

2018
136. When comparing whey and casein for geriatric muscle recovery, what makes whey protein particularly advantageous?
(A) It digests at a significantly slower rate, preventing sudden aminoacidemia
(B) It has a higher concentration of leucine, a key trigger for muscle synthesis
(C) It forms a gel in the acidic stomach environment, ensuring long-term physical satiety
(D) It lacks any functional bioactive properties that interfere with medications

2016
137. Which technological method is most effectively utilized to reduce the lactose load in geriatric milk without diminishing its fundamental protein content?
(A) Diluting the milk heavily with high-purity deionized water
(B) Boiling the raw milk until lactose molecules physically evaporate
(C) Treating the milk with exogenous beta-galactosidase enzymes
(D) Adding massive amounts of lactic acid to burn off residual sugars

2024
138. Which distinct group of amino acids forms the functional core of branched-chain amino acids (BCAAs) heavily utilized in dairy-based sports foods?
(A) Tyrosine, Tryptophan, Phenylalanine
(B) Glycine, Alanine, Serine
(C) Arginine, Histidine, Lysine
(D) Leucine, Isoleucine, Valine

2010
139. How is a Whey Protein Isolate (WPI) accurately defined in comparison to a Whey Protein Concentrate (WPC)?
(A) WPI is processed to contain ninety percent

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or more protein with minimal fat and lactose
(B) WPI contains less than thirty percent protein while retaining high lactose levels
(C) WPI is simply raw, unpasteurized liquid whey collected from the cheese vats
(D) WPI is heavily fortified with added saturated fats to boost caloric density

2016
140. Consider the following statements regarding dairy proteins in sports nutrition:
I. Whey is categorized as a "fast" protein due to its rapid gastric emptying and absorption.
II. Casein forms a gel in the acidic stomach environment, providing a slow, sustained release of amino acids.
III. Consuming casein post-workout is strictly detrimental to muscle recovery.
Which of the above statements are correct?
(A) I and II
(B) Only I
(C) II and III
(D) I and III

2002
141. What physiological phenomenon describes the "muscle recovery window" heavily targeted by whey-based sports formulations?
(A) A brief physiological window before working out where skeletal muscles are paralyzed
(B) The post-exercise period when muscle cells show high sensitivity to amino acid uptake
(C) A deep sleep period during which the metabolic system actively rejects dietary protein
(D) The exact physiological moment of complete muscle failure during heavy weightlifting

2006
142. Identify the INCORRECT statement concerning muscle recovery kinetics related to dairy consumption.
(A) Dairy proteins cause severe muscle catabolism if consumed immediately after a workout
(B) Co-ingestion of dairy carbohydrates and proteins can accelerate glycogen resynthesis
(C) Fast aminoacidemia from whey sharply stimulates muscle protein synthesis
(D) The leucine trigger hypothesis suggests a specific threshold of leucine is needed to initiate anabolism

2009
143. What is the direct biochemical effect of the BCAA leucine on muscle cells following exercise?
(A) It aggressively degrades myofibrillar protein structures during high exertion
(B) It instantly blocks the cellular absorption of glucose under normal conditions
(C) It activates the mTOR signaling pathway, initiating muscle protein translation
(D) It biochemically converts directly into active bone marrow stem cell units

2019
144. Match the sports formulation component listed in List I with its intended functional role listed in List II:
List I: Sports Formulation Component
P. Micellar Casein
Q. Whey Protein Hydrolysate
R. Maltodextrin (added to dairy)
S. Electrolytes (Na, K)
List II: Intended Functional Role
1. Rapid replenishment of muscle glycogen stores
2. Rehydration and fluid balance restoration
3. Ultra-fast delivery of pre-digested di- and tri-peptides
4. Sustained nocturnal amino acid delivery to prevent catabolism
(A) P-1, Q-2, R-3, S-4
(B) P-3, Q-1, R-4, S-2
(C) P-2, Q-4, R-1, S-3
(D) P-4, Q-3, R-1, S-2

2008
145. Which of the following is NOT a recognized functional benefit of using Whey Protein Concentrates in sports beverage formulations?
(A) Providing highly bioavailable essential amino acids
(B) Contributing bioactive fractions like immunoglobulins that support immune function during heavy training
(C) Serving as a major source of dietary fiber to promote colon motility
(D) Exhibiting high solubility across a wide pH range

NODIA

2018
146. In comparing protein processing methods, what makes Whey Protein Hydrolysates (WPH) distinctively superior for elite sports recovery despite their typical bitter taste?
(A) They contain extremely high levels of lactose to provide continuous sustained energy

(A) Advertising heavily with prominent labels showing "Zero Salt" on the front packaging
(B) Removing sodium incrementally across production cycles without informing consumers on labels
(C) Substituting sodium chloride directly with unregistered and illegal synthetic chemicals
(D) Restricting retail operations by selling low-sodium products exclusively at midnight

2003

179. How is "lactose intolerance" officially defined in clinical gastroenterology?
(A) An intense, life-threatening systemic allergic reaction to all milk proteins
(B) A deep-seated psychological or sensory aversion to the visual appearance of milk
(C) An acute, severe toxic shock reaction triggered by consuming spoiled fermented dairy
(D) Gastrointestinal distress caused by deficiency of the intestinal enzyme lactase

2009

180. Consider the following statements regarding the production of low-lactose milk:
I. The enzyme used is exclusively derived from mammalian stomachs.
II. Lactase hydrolyzes lactose into glucose and galactose.
III. Commercial lactase is typically sourced from yeasts like Kluyveromyces lactis or fungi like Aspergillus oryzae.
IV. Enzymatic hydrolysis reduces the sweetness of the milk.
Which of the above statements are correct?
(A) II and III
(B) I and IV
(C) I, II, and III
(D) II, III, and IV

2008

181. What is the direct cause of the intensified Maillard browning often observed in lactose-hydrolyzed UHT milk during storage?
(A) The lactase enzyme preparation itself is dark brown and directly stains the liquid milk
(B) The enzymatic process raises milk pH, accelerating thermal caramelization reactions
(C) The hydrolysis creates glucose and galactose, which are highly reactive reducing sugars
(D) The complete removal of proteins leaves free reducing sugars highly exposed to light

2021

182. Which specific application point characterizes the "aseptic or post-pasteurization" method of lactase addition in low-lactose milk production?
(A) Sterile enzyme is injected into the milk after UHT treatment and before packaging
(B) The active enzyme is directly added to raw cold milk and then immediately boiled
(C) The concentrated liquid enzyme is sprayed onto the exterior of the cardboard carton
(D) The bulk agricultural enzyme is mixed directly into the daily feed of the dairy cow

2021

183. Identify the INCORRECT statement concerning the enzymatic hydrolysis of lactose.
(A) It significantly increases the relative sweetness of the final dairy product
(B) It lowers the freezing point of the milk mix, requiring adjustments in ice cream manufacturing
(C) It increases the fermentability of the milk by certain starter cultures
(D) It causes the milk to instantly curdle and form a hard cheese-like matrix

2013

184. In terms of processing challenges, how does one technologically mitigate the excessive Maillard browning in lactose-free milk powder?
(A) By holding the dry milk powder at extremely elevated humidity and temperature
(B) By ultra-filtering out lactose before drying instead of only hydrolyzing it
(C) By heavily fortifying the dry milk powder with active iron and copper catalysts
(D) By completely eliminating the industrial spray drying process from the plant

2015

185. Match the lactose-reduction technology listed in List I with its underlying physical or chemical principle listed in List II:
List I: Technology
P. Chromatographic separation
Q. Enzymatic hydrolysis
R. Ultrafiltration
S. Fermentation
List II: Principle
1. Cleavage of the beta-1,4 glycosidic bond
2. Physical size-exclusion of molecules through a semi-permeable membrane
3. Biological conversion of lactose into lactic acid
4. Fractionation based on molecular affinity

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2015

154. Which of the following ingredients is specifically considered low-GI and appropriate for sweetening a diabetic-friendly dairy beverage?
(A) High Maltose Corn Syrup
(B) Dextrose anhydrous
(C) Maltodextrin (DE 20)
(D) Erythritol

2017

155. A standard high-protein, low-carbohydrate therapeutic dairy food is appropriate for all of the following conditions EXCEPT:
(A) Severe renal failure requiring strict protein restriction
(B) Type 2 diabetes requiring low glycemic index diets
(C) Sarcopenic obesity requiring muscle retention plans
(D) General weight management focused on lowering calories

2006

156. In the classification of functional fats for cardiovascular health, how do Mono-Unsaturated Fatty Acids (MUFAs) like oleic acid compare to typical dairy saturated fats?
(A) MUFAs are solid at room temperature and strongly increase serum LDL levels
(B) MUFAs lower LDL cholesterol without reducing HDL, unlike saturated fats
(C) MUFAs are found only in marine algae and never in modified dairy matrices
(D) MUFAs trigger immediate, aggressive lipid auto-oxidation in raw liquid milk

2022

157. What is the direct physiological effect of formulating a therapeutic yogurt with specifically high levels of whey-derived ACE-inhibitory peptides?
(A) Severe hypoglycemia and sudden drops in blood glucose levels
(B) A significant reduction in systemic arterial blood pressure
(C) Massive systemic water retention and chronic peripheral edema
(D) Immediate precipitation of calcium-based kidney stones

2006

158. Which specific technological challenge arises when fully replacing milk fat with therapeutic plant sterols in a liquid milk formulation?
(A) Maintaining a stable emulsion and preventing lipophilic sterol separation
(B) Plant sterols vaporizing into a gaseous state at normal room temperature
(C) Plant sterols reacting with raw milk lactose to produce toxic sulfide gas
(D) Plant sterols transforming liquid milk into a solid, rock-like curd matrix

2003

159. How is "fat replacer" defined in reduced-calorie dairy food technology?
(A) A chemical that strictly increases the overall caloric density of foods
(B) An enzyme formulation that actively burns body fat upon human consumption
(C) An ingredient that mimics fat properties but contributes fewer calories
(D) A highly toxic synthetic preservative that has been banned by food safety authorities

2006

160. Which renowned commercial fat replacer is specifically derived from microparticulated whey protein?
(A) Olestra
(B) Sucralose
(C) Inulin
(D) Simplesse

2003

161. What is the specific physiological mechanism that makes Erythritol a near-zero calorie sweetener?
(A) It temporarily paralyzes the human digestive tract to stop carbohydrate absorption
(B) It physically burns an equivalent amount of thermal calories during active digestion
(C) It is absorbed into the blood but cannot be metabolized, being excreted unchanged
(D) It is composed of complex polysaccharide fibers that require several days to chew

2001

162. How does the application of microparticulated whey protein successfully simulate the mouthfeel of dairy fat in a low-calorie yogurt?
(A) The proteins are chemically mutated into true functional lipid triglycerides upon heating
(B) The proteins are micro-particulated into spheres that mimic fat droplets on the tongue
(C) The protein molecules emit a faint static electrical charge that numbs consumer palate
(D) The protein aggressively binds to human saliva to form a thick, protective mucilage layer

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(B) They bypass digestive steps as they are pre-cleaved, enabling faster absorption
(C) They are completely resistant to all stomach acids and digestive enzymes in vivo
(D) They instantly solidify into a gel matrix upon contacting human salivary amylase

2021

147. Which classification best describes a sports recovery drink formulated with 80% casein and 20% whey, fortified with complex carbohydrates?
(A) An intra-workout rapid-acting carbohydrates and energy gel
(B) A pre-workout stimulant targeting the central nervous system
(C) An instant, ultra-fast hydration tonic with electrolytes
(D) A night-time or prolonged recovery sustained-release matrix

2024

148. How is the Glycemic Index (GI) formally defined in the context of therapeutic dairy foods for diabetes?
(A) A measure of how fast a food raises blood glucose compared to a reference food
(B) The exact measurement of total lipid and fat grams contained in a dairy serving
(C) The chemical speed at which milk proteins coagulate in the acidic gastric stomach
(D) A comparative scale determining the intensive artificial sweetness of a product

2006

149. Which specific formulation adjustment is most critical when designing a cardiovascular-protective therapeutic dairy product?
(A) Maximizing the saturated lipid content to increase oxidative shelf stability
(B) Adding massive quantities of standard sodium chloride to enhance overall flavor
(C) Replacing dairy fat with plant sterols or functional omega-3 fatty acids
(D) Removing all micronutrients and vitamins to strictly isolate the pure protein

2022

150. Identify the INCORRECT statement regarding the formulation of diabetes-friendly therapeutic dairy foods.
(A) Sucrose is heavily preferred as a bulking sweetener due to its high GI
(B) Resistant starches and soluble fibers can be added to slow carbohydrate absorption
(C) The natural lactose in milk has a relatively low glycemic index compared to glucose
(D) High protein content in dairy can actually help stabilize postprandial blood sugar levels

NODIA

2001

151. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): The incorporation of phytosterols into functional milk reduces serum LDL cholesterol in hyperlipidemic patients.
Reason (R): Phytosterols structurally mimic cholesterol and competitively inhibit its absorption in the human intestine.
(A) Both (A) and (R) are true and (R) is the correct explanation of (A).
(B) Both (A) and (R) are true but (R) is not the correct explanation of (A).
(C) (A) is true but (R) is false.
(D) (A) is false but (R) is true.

2004

152. What is the precise biochemical mechanism by which beta-glucan addition to dairy matrices assists in managing metabolic disorders?
(A) It dramatically increases the rate of cellular lipid oxidation and fat metabolism
(B) It forms a viscous gel in the gut, trapping bile acids and blunting glucose spikes
(C) It completely stops the human liver and pancreas from synthesizing endogenous insulin
(D) It permanently coats the tongue papillae, preventing any perception of sweetness

2003

153. Consider the following statements regarding therapeutic dairy ingredients for metabolic disorders:
I. Dietary fiber decreases the energy density of the food.
II. Peptides containing the sequence Val-Pro-Pro (VPP) exhibit strong ACE-inhibitory activity beneficial for hypertension.
III. High-GI carbohydrates are essential for managing Type 2 diabetes.
Which of the above statements are correct?
(A) I and II
(B) Only II
(C) I and III
(D) Only I

2014

171. Identify the INCORRECT statement regarding the crucial technological roles of sodium chloride in traditional cheese manufacturing.
(A) It completely halts all enzymatic ripening and flavor development permanently
(B) It strictly controls the water activity, thereby regulating microbial growth and spoilage
(C) It heavily influences the physical structure and protein hydration of the cheese curd
(D) It acts as a potent enhancer for characteristic cheese flavors

2002

172. What precise physiological or sensory limitation severely restricts a direct 1:1 replacement of NaCl with KCl in dairy products?
(A) KCl is highly toxic to metabolic systems and lethal even in trace amounts
(B) KCl imparts an objectionable bitter and metallic off-flavor at high levels
(C) KCl reacts violently with native casein structures to produce explosive gas
(D) KCl chemically reacts with milk fats to turn the cheese a fluorescent green

2001

173. Identify the INCORRECT statement regarding the cause and effect of severely reducing salt in a standard Cheddar cheese formulation.
(A) Cause: Higher water activity. Effect: Increased survival and growth of non-starter lactic acid bacteria, potentially leading to off-flavors.
(B) Cause: Lower osmotic pressure. Effect: Complete inhibition of all lactic acid bacteria, resulting in zero acid development.
(C) Cause: Altered protein hydration. Effect: Softening of the cheese body, making it pasty or weak.
(D) Cause: Reduced salt-to-moisture ratio. Effect: Uncontrolled proteolysis, which often leads to the development of a bitter taste.

2009

174. Consider the following statements regarding strategies for low-sodium dairy formulations:
I. Stepwise, gradual reduction of salt over time to allow consumer palate adaptation.
II. Utilizing yeast extracts or umami compounds to enhance the perception of saltiness.
III. Replacing salt entirely with pure crystalline sucrose.
IV. Modifying the physical crystal structure of salt to increase its dissolution speed on the tongue.
Which of the above statements are correct?
(A) I, II, and IV
(B) II, III, and IV
(C) I, III, and IV
(D) I, II, and III

2023

175. Match the low-sodium strategy listed in List I with its underlying mechanism listed in List II:
List I: Strategy
P. Potassium chloride addition
Q. Yeast extract addition
R. Hollow salt crystals
S. Stepwise reduction
List II: Mechanism
1. Increases spatial flavor perception with less total mass
2. Cross-modal sensory enhancement via umami synergy
3. Direct ionic substitution of sodium
4. Gradual neuro-sensory adaptation of the consumer
(A) P-3, Q-2, R-1, S-4
(B) P-1, Q-4, R-3, S-2
(C) P-4, Q-1, R-2, S-3
(D) P-2, Q-1, R-4, S-3

2010

176. Salt performs all of the following functional roles in butter manufacturing EXCEPT:
(A) Acting as a primary preservative by partitioning into the aqueous phase
(B) Enhancing the overall flavor profile
(C) Suppressing the growth of specific spoilage microorganisms
(D) Acting as a potent fat replacer to lower total calories

2008

177. When comparing mineral modification techniques in cheese, what happens if sodium is entirely removed without any ionic replacement?
(A) The cheese achieves an extremely smooth, uniform, and stable curd texture
(B) The cheese curds spontaneously combust under standard warehouse pressures
(C) The para-casein network becomes over-hydrated and weak, destroying the body
(D) The cheese ripens ten times faster while developing sensory flavor

2016

178. What classifies as a “stealth reduction” strategy in low-sodium dairy commercialization?

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2010
163. Identify the INCORRECT statement regarding the use of low-calorie intensive sweeteners in dairy foods.
(A) Sucralose is derived from sucrose but structurally modified with chlorine atoms
(B) Steviol glycosides provide sweetness from a natural plant source
(C) Intensive sweeteners provide sweetness without adding significant bulk or viscosity
(D) Aspartame is highly stable under severe thermal processes like UHT and baking

2001
164. Determine the correct selection order of the following sweeteners arranged from lowest to highest relative sweetness potency compared to sucrose.
I. Lactose
II. Sucrose
III. Aspartame
IV. Neotame
(A) II → I → III → IV
(B) I → II → IV → III
(C) I → II → III → IV
(D) II → I → IV → III

2025
165. Why is a "bulking agent" often absolutely necessary when reformulating a dairy product with intense artificial sweeteners?
(A) Because intensive sweeteners drastically lower the final product pH to unsafe acid levels
(B) Because pure concentrated intensive sweeteners behave as highly explosive dust compounds
(C) To replace physical mass, volume, and texture lost when high-volume sugars are removed
(D) To completely mask the natural white color of milk proteins and prevent discoloration

2009
166. Match the reduced-calorie ingredient listed in List I with its chemical classification listed in List II:
List I: Reduced-Calorie Ingredient
P. Maltodextrin
Q. Simplesse
R. Sucralose
S. Polydextrose
List II: Chemical Classification
1. Protein-based fat replacer
2. Carbohydrate-based fat replacer/bulking agent
3. Synthetic high-intensity sweetener
4. Synthetic highly-branched polymer/bulking agent
(A) P-2, Q-1, R-3, S-4
(B) P-1, Q-2, R-4, S-3
(C) P-3, Q-4, R-1, S-2
(D) P-4, Q-3, R-2, S-1

2012
167. Which of the following ingredients CANNOT be utilized as a carbohydrate-based fat replacer in dairy products?
(A) Modified food starch
(B) Cellulose gel
(C) Pectin
(D) Mineral oil

2005
168. In comparing fat replacement strategies, what fundamentally restricts the use of protein-based fat replacers like Simplesse in baked dairy products or processed cheese?
(A) They are completely illegal to incorporate into any solid or semi-solid food products
(B) They denature and gel at high temperatures, losing their smooth fat-mimicking texture
(C) They dramatically increase the total measurable saturated fat content upon heating
(D) They evaporate entirely during standard commercial baking and sterilization processes

2010
169. What is the standard and most frequently utilized chemical compound for replacing sodium chloride (salt) in low-sodium dairy formulations?
(A) Calcium carbonate
(B) Magnesium sulfate
(C) Potassium chloride
(D) Sodium bicarbonate

2003
170. How is "bitterness masking" specifically defined in the context of low-sodium cheese processing?
(A) The direct physical removal of all bitter amino acids and peptides from the cheese matrix
(B) The technological process of painting the cheese crust with dark colored edible waxes
(C) The cryogenic freezing of the final product to temporarily deaden consumer taste buds
(D) Using specific flavor modulators to hide the metallic off-notes of potassium chloride

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and simulated moving beds
(A) P-1, Q-4, R-3, S-2
(B) P-2, Q-3, R-1, S-4
(C) P-4, Q-1, R-2, S-3
(D) P-3, Q-2, R-4, S-1

2025
186. All of the following are sensory effects typically noted in 100% lactose-hydrolyzed milk EXCEPT:
(A) A distinctly sweeter taste profile
(B) A slightly thinner perceived viscosity
(C) A darker color progression during prolonged ambient storage
(D) A strong, pungent metallic bitterness resembling potassium chloride

2006
187. What makes fungal lactases (e.g., from Aspergillus niger) distinctively useful compared to yeast lactases in certain dairy applications?
(A) Fungal lactases have a lower optimal pH, making them ideal for acidic whey or yogurts
(B) Fungal lactases possess a highly alkaline optimal pH range for basic conditions
(C) Fungal lactases are structurally restricted to functioning at sub-zero temperatures
(D) Fungal lactases metabolically convert lactose molecules directly into active alcohol

2002
188. Determine the classification of the following product: A dairy beverage where lactose has been entirely mechanically filtered out and replaced with a non-caloric sweetener, yielding a zero-sugar milk.
(A) Pure intact skim milk
(B) Ultra-filtered, zero-carbohydrate dairy beverage
(C) Standard enzymatically hydrolyzed lactose-free milk
(D) Traditional sweetened condensed milk

2015
189. What defines the fundamental operating principle of electrodialysis (ED) in the demineralization of milk and whey?
(A) Forcing whey components through a micro-porous screen using high hydrostatic pressure
(B) Ionized mineral migration through ion-selective membranes driven by electrical current
(C) The rapid physical boiling of liquid whey in order to strictly evaporate mineral ash
(D) The selective biological consumption of inorganic minerals by specialized bacteria

2012
190. Identify the correct statement regarding the application of ion exchange (IE) resins in whey demineralization.
(A) IE passes whey through polymer beads exchanging mobile counter-ions for mineral ions
(B) IE specifically and exclusively removes uncharged neutral sugars like pure lactose
(C) IE relies entirely on extreme centrifugal forces to physically spin minerals out
(D) IE is completely and fundamentally ineffective at removing ionic calcium or magnesium

2024
191. What is the specific molecular weight cut-off (MWCO) range typically associated with nanofiltration (NF) membranes used in the dairy industry?
(A) 10 to 50 Daltons, which limits the passage of almost all ionic minerals and water
(B) 10,000 to 50,000 Daltons, designed specifically for ultrafiltration of proteins
(C) 150 to 1000 Daltons, retaining organic lactose while passing monovalent ions and water
(D) Over 1,000,000 Daltons, which is typical for microfiltration of fat globules

2012
192. How does the demineralization of whey directly facilitate its application in premium infant formulas?
(A) It dramatically increases the electrical conductivity of whey to support healthy growth
(B) It permanently and heavily denatures whey proteins, making them completely indigestible
(C) It rapidly and chemically converts the liquid whey into a stable solid matrix without heat
(D) It lowers the mineral ash content of whey, preventing osmotic overload in infant kidneys

2001
193. Identify the INCORRECT statement comparing electrodialysis (ED) and ion exchange (IE).
(A) IE generally allows for a much higher total demineralization percentage (up to 95-99%) than a standard single-pass ED system
(B) ED systems are highly sensitive to severe protein fouling on the membrane surfaces
(C) ED is vastly superior for removing non-ionic compounds compared to IE

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27. (B) Sensory acceptability is irrelevant if the health benefit is proven
Sensory acceptability is critical for the commercial success of functional dairy foods; consumers will not repeatedly purchase bad-tasting products regardless of proven health benefits. While regulatory approvals can delay launches, clinical validation increases development costs, and premium pricing helps recover research and development investments, maintaining excellent taste and texture remains a non-negotiable factor for market viability.

28. (A) It increased consumer demand for immunity ingredients like lactoferrin
The global pandemic significantly increased consumer demand for dairy products containing immunity-boosting ingredients, such as lactoferrin and bioactive peptides. This public health crisis heightened awareness of preventive nutrition, driving interest in functional foods that support immune defense. This shift accelerated market growth and research into therapeutic dairy proteins rather than halting clinical trials or reducing overall demand.

29. (C) Providing transparent, clinically backed substantiation
Providing transparent, clinically backed scientific substantiation is the most effective strategy for overcoming consumer skepticism toward functional dairy claims. Consumers increasingly demand evidence for health claims. Using overly complex chemical jargon, excessive sugars to mask flavors, or making unproven assertions of miracle cures undermines credibility and harms long-term brand trust in the competitive food market.

30. (D) Maintaining strain viability through processing and distribution
A unique technological challenge in scaling up probiotic dairy food production is maintaining sufficient strain viability throughout manufacturing, storage, and distribution. Probiotics must remain live and active until consumption to deliver health benefits. This requires careful control of parameters like heat exposure, dissolved oxygen, and acidity, which is more complex than standard dairy processing tasks.

31. (C) Emerging markets show high growth due to dietary transitions
The primary difference between functional food markets is that emerging economies exhibit high growth driven by rapid dietary transitions, rising disposable incomes, and urbanization. While developed nations have mature markets with a focus on specialized clinical nutrition, emerging markets present expanding opportunities as consumers shift from basic nutrition toward health-promoting, fortified dairy and food products.

32. (B) An active peptide sequence released from a parent protein
A bioactive peptide is defined as a specific, short sequence of amino acids that remains inactive within the parent milk protein molecule until released. These peptides are liberated during gastrointestinal digestion or food fermentation. Once released, they exert specific physiological effects in the body, such as antihypertensive, antimicrobial, immunomodulatory, or mineral-binding activities.

33. (D) By blocking the conversion of angiotensin I to angiotensin II
ACE-inhibitory peptides derived from milk proteins help manage hypertension by blocking the action of angiotensin-converting enzyme. This enzyme normally converts angiotensin I into the potent vasoconstrictor angiotensin II. By inhibiting this conversion, these bioactive peptides facilitate blood vessel relaxation, which reduces peripheral vascular resistance and helps maintain healthy, stable blood pressure levels.

34. (A) Proteolytic hydrolysis via pepsin or trypsin
The release of casokinins from intact casein micelles requires proteolytic hydrolysis, which is typically mediated by digestive enzymes such as pepsin or trypsin. This biochemical cleavage breaks down the large parent protein structure into smaller, active peptide fragments. Physical processes like high-pressure homogenization, thermal pasteurization, or centrifugal separation cannot break peptide bonds to release these bioactives.

35. (C) Kappa-casein — GMP
Glycomacropeptide is a bioactive peptide cleaved specifically from kappa-casein during the rennet coagulation process in cheesemaking. Other pairings are incorrect because casomorphins

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2005

202. How do the unique properties of sweet buttermilk technically enhance the formulation of value-added ice cream?

(A) Its complete lack of active proteins ensures the final ice cream never melts
(B) Its intense sensory saltiness completely replaces the need for added sugar
(C) It possesses a unique freezing point that naturally occurs at 100 degrees Celsius
(D) Its MFGM phospholipids act as natural emulsifiers, improving overrun and texture

2014

203. Identify the INCORRECT statement regarding the preservation and drying of buttermilk.

(A) Buttermilk powder possesses an indefinite shelf-life at high temperatures without any packaging protection
(B) Buttermilk powder is highly susceptible to rapid lipid oxidation during storage due to its high phospholipid content
(C) Spray drying is the most common commercial method for converting buttermilk into a stable powder
(D) Condensing the buttermilk before drying significantly improves the energy efficiency of the process

2010

204. What causes the distinct, rich, slightly nutty flavor profile inherently found in high-quality dry sweet buttermilk powder?

(A) The intentional addition of crushed almonds and hazelnut extracts during the spray drying phase
(B) Volatile fatty acids, sulfhydryl compounds, and phospholipids generated during processing
(C) The complete chemical putrefaction of residual lactose sugars inside the dryer system
(D) The total physiological absence of all functional milk proteins and casein molecules

2001

205. Arrange the following steps in the correct sequence for the industrial production of standard sweet buttermilk powder:

I. Spray drying the concentrated liquid
II. Churning of sweet cream and draining the aqueous phase
III. Pasteurization of the raw buttermilk
IV. Evaporation/Concentration of the pasteurized buttermilk

(A) II → IV → III → I
(B) II → III → IV → I
(C) III → II → IV → I
(D) IV → I → II → III

2021

206. Match the buttermilk-derived component listed in List I with its potential functional or therapeutic application listed in List II:

List I: Component

P. Sphingomyelin
Q. Phosphatidylserine
R. Buttermilk proteins
S. Lactic acid (in sour buttermilk)

List II: Application

1. Natural mild antimicrobial and flavoring agent
2. Structural emulsifier in baked goods
3. Neurological support and cognitive function enhancement
4. Cellular signaling and potential cholesterol modulation

(A) P-4, Q-3, R-2, S-1
(B) P-3, Q-4, R-1, S-2
(C) P-2, Q-1, R-4, S-3
(D) P-1, Q-2, R-3, S-4

2025

207. Sweet buttermilk powder is a viable value-added ingredient for all of the following applications EXCEPT:

(A) Incorporation into premium commercial bakery products
(B) Use in the formulation of high-quality milk chocolate to enhance viscosity
(C) Direct processing into hard, aged Cheddar cheese as the sole ingredient
(D) Utilization as a natural emulsifier in salad dressings

2007

208. When comparing sweet and sour buttermilk industrially, why is sweet buttermilk heavily preferred for large-scale spray drying?

(A) Sour buttermilk fundamentally lacks all polar lipids and key functional phospholipids
(B) Sweet buttermilk naturally exits the churn directly as a dry and fine flowing powder
(C) Sweet buttermilk possesses a biological pH of 1.0, making it completely sterile
(D) Sour buttermilk acidity reduces protein heat stability, causing dryer clogging and corrosion

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2024

209. How is "ghee residue" defined in Indian dairy processing?
(A) The pure, highly clarified liquid butterfat layer recovered immediately after thermal heating
(B) The aqueous liquid stream drained transparently and completely from the butter churner
(C) The brownish solid containing protein, lactose, and fat, recovered during ghee clarification
(D) A synthetic chemical flavor additive specifically formulated to scent cheap margarines

2016

210. Which primary macromolecule typically forms the highest percentage of the dry matter weight in unpressed standard ghee residue?
(A) Pure crystalline lactose
(B) Entrapped milk fat
(C) Insoluble dietary fiber
(D) Intact native immunoglobulins

2008

211. Consider the following statements regarding the chemical properties of ghee residue:
I. It exhibits extremely potent natural antioxidant properties.
II. It is highly abundant in heavily complexed Maillard reaction products like melanoidins.
III. It contains absolutely zero percent fat.
IV. Its primary use historically has been purely as industrial fertilizer.
Which of the above statements are correct?
(A) I and II
(B) II and III
(C) III and IV
(D) Only I

2011

212. How is ghee residue technologically utilized to enhance flavor formulations in commercial bakery products?
(A) By utilizing its caramelized, cooked-butter flavor compounds to enrich bakery products
(B) By completely replacing all of the starch and wheat flour in the recipe formulation
(C) By bleaching the byproduct totally white and incorporating it as a tasteless filler
(D) By using it strictly as a chemical agent to violently bleach the raw dough

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2008

213. Identify the INCORRECT statement concerning the recovery and handling of ghee residue.
(A) Pressing or centrifugation is often employed to extract the high amount of residual entrapped fat, yielding a defatted residue
(B) Unpressed ghee residue can rapidly turn rancid if exposed to moisture and air due to its high fat content
(C) The extreme heat of ghee making ensures the residue contains highly intact, un-denatured whey proteins
(D) It is fundamentally a concentrated matrix of thermally altered non-fat milk solids

2022

214. What causes the definitive dark brown coloration of standard ghee residue?
(A) Maillard browning and lactose caramelization at temperatures over 110 degrees
(B) The natural, biological presence of high levels of cocoa powder in cow's milk
(C) The direct synthesis of pure organic melanin by heat-shocked bacterial cells
(D) The severe chemical oxidation of pure physical ascorbic acid under ambient conditions

2015

215. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): Extracts of ghee residue are highly effective at extending the shelf life of other fat-based products.
Reason (R): Ghee residue contains a high concentration of natural antioxidants, including phospholipids and sulfhydryl compounds, liberated during high-heat treatment.
(A) Both (A) and (R) are true and (R) is the correct explanation of (A).
(B) Both (A) and (R) are true but (R) is not the correct explanation of (A).
(C) (A) is true but (R) is false.
(D) (A) is false but (R) is true.

2003

216. Ghee residue can be utilized for all of the following applications EXCEPT:
(A) Formulation of traditional Indian sweets (mithai) like pinni or burfi
(B) Direct intravenous injection as a clinical nutritional supplement
(C) Extraction of the entrapped fat to produce lower-grade commercial cooking fats

(D) Blending into cattle or poultry feed formulations as an energy-dense supplement

2002

217. When comparing the composition of ghee residue to raw milk, what is entirely true regarding its protein fraction?
(A) The proteins remain highly soluble and stable in their native micellar state
(B) The proteins consist almost exclusively of pure, biologically active lactoferrin
(C) The proteins are denatured, cross-linked, and coprecipitated with lactose and fat
(D) The protein content is completely evaporated and lost during the boiling process

2019

218. Which of the following classifications best describes ghee residue in dairy processing?
(A) A primary, high-quality fluid milk product sold in retail markets
(B) A highly toxic, heavily regulated hazardous chemical waste material
(C) A synthetic pharmaceutical compound used for medical purposes
(D) A nutritional thermal byproduct with potential for upcycling

2005

219. How is "whey permeate" defined in the context of dairy byproduct utilization?
(A) The lactose- and mineral-rich stream passing through an ultrafiltration membrane
(B) The highly concentrated protein stream that is strictly retained by the membrane
(C) The solid, dry cake structure left behind after spray drying fluid whole milk
(D) The purified layer of concentrated milk fat separated via high-speed centrifugation

2004

220. Which specific molecule constitutes the overwhelming majority (greater than 80%) of the dry matter in standard whey permeate?
(A) Alpha-lactalbumin
(B) Lactose
(C) Triglycerides
(D) Casein

2002

221. Identify the correct statement characterizing liquid "retentate" obtained from the ultrafiltration of sweet whey.
(A) It is severely depleted of all functional proteins and consists solely of pure process water
(B) It contains concentrated intact whey proteins, lipids, and minerals from the original whey
(C) It is definitively composed of one hundred percent pure lactic acid and organic compounds
(D) It is an incredibly dry, highly stable milk powder collected directly from the membrane

2024

222. How is dairy permeate technologically utilized in the extrusion cooking of snack foods?
(A) It blends with cereals to act as a browning and flavor agent via Maillard reactions
(B) It completely and permanently stops the extruder machinery from functioning
(C) It is utilized strictly to freeze and solidify the hot snack matrix instantly
(D) It acts purely as a highly concentrated, potent synthetic green food dye agent

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2009

223. Identify the INCORRECT statement regarding the industrial spray drying of whey permeate.
(A) The extreme hygroscopicity of pure amorphous lactose causes severe sticking and caking inside the drying chamber
(B) Strict pre-crystallization of the lactose is absolutely mandatory before drying to prevent total collapse of the powder
(C) Permeate powder behaves identically to highly stable, pure sand during the drying process
(D) High concentrations of lactic acid in acid whey permeate further drastically lower the glass transition temperature, complicating drying

2024

224. What directly causes the primary operational difficulty (stickiness) when drying high-lactose dairy byproducts like permeate?
(A) The complete and total absence of all molecular moisture within the drying chamber system
(B) The exceptionally high freezing point of pure water molecules under vacuum conditions
(C) The massive size of dairy protein molecules blocking the high-speed atomizer nozzle
(D) The low glass transition temperature of lactose and organic acids, making the matrix rubbery

2024

225. Match the dairy byproduct stream listed in List I with its standard value-added application listed in List II:

List I: Byproduct Stream

P. Whey Permeate
Q. Liquid Whey Retentate
R. Delactosed Permeate (Mother Liquor)
S. Acid Whey Permeate

List II: Value-Added Application

1. Fermentation substrate for ethanol/lactic acid due to challenging drying properties
2. Precursor for highly concentrated WPC/ WPI drying
3. Low-cost carbohydrate bulking/browning agent in bakery
4. Rich mineral source for lick-blocks in animal feed

(A) P-3, Q-2, R-4, S-1
(B) P-4, Q-3, R-1, S-2
(C) P-3, Q-2, R-4, S-1
(D) P-1, Q-4, R-2, S-3

2011

226. All of the following are viable technological solutions for combating stickiness during permeate drying EXCEPT:

(A) Intensive pre-crystallization of the concentrate in specialized tanks
(B) Drastically increasing the relative humidity of the inlet drying air to 100%
(C) Utilizing specialized fluid bed cooling stages post-drying
(D) Blending the permeate with stable carriers like maltodextrin before drying

2011

227. When comparing utilization strategies, why is whey permeate often extensively utilized as a substrate for industrial fermentation rather than direct human food?

(A) Because raw fluid whey permeate is highly lethal to human health in any normal dosage
(B) Because it instantly solidifies into an unbreakable, highly crystalline structure
(C) Because commercial fermentation processes strictly require pure, unadulterated milk fat
(D) Its high lactose serves as a cheap carbon source for bioethanol or single-cell proteins

2025

228. What fundamental physical property must be aggressively managed to successfully formulate stable blended powders containing heavily hygroscopic dairy permeates?

(A) The glass transition temperature in relation to storage temperature and humidity
(B) The precise physical magnetic resonance and static charge of the powder particles
(C) The absolute physical elimination of all gravitational forces inside the storage silo
(D) The radioactive decay rate and isotopic molecular breakdown of the lactose sugars

2018

229. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).

Assertion (A): Blending dairy retentate powders with extruded cereal matrices significantly increases the final product's physical expansion index (puffing).

Reason (R): High levels of intact whey proteins strictly inhibit the rapid flashing off of steam at the extruder die.

(A) Both (A) and (R) are true and (R) is the correct explanation of (A).
(B) Both (A) and (R) are true but (R) is not the correct explanation of (A).
(C) (A) is true but (R) is false.
(D) (A) is false but (R) is true.

2002

230. In the classification of drying technologies for incredibly difficult, sticky dairy byproducts (like acid whey permeate), which alternative is occasionally utilized despite its significantly higher operational cost compared to spray drying?

(A) Freeze drying (Lyophilization)
(B) Sun-drying on open concrete
(C) Direct boiling over an open flame
(D) High-pressure homogenization

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ANSWERS

1. (D) A food formulation offering physiological benefits beyond basic nutrition
Functional foods are specifically defined as dietary items that provide physiological benefits and reduce the risk of chronic diseases beyond basic nutritional functions. These formulations contain bioactive compounds that support bodily health and target specific physiological pathways, distinguishing them from traditional pharmaceutical treatments, refined foods lacking nutrients, or simple herbal remedies.

2. (A) Human clinical trials demonstrating physiological efficacy
Regulatory bodies mandate robust scientific evidence to substantiate health claims on dietary supplements. Conducting human clinical trials remains the gold standard for demonstrating physiological efficacy and safety. Alternative methods like simple in vitro assays, consumer preference surveys, or anecdotal evidence are insufficient because they fail to provide rigorous, scientifically validated proof within human biological systems.

3. (C) I and III
Under Indian food safety regulations, nutraceuticals are legally permitted to contain ingredients listed under Schedule VI. These regulations explicitly state that nutraceutical products must not claim to cure, mitigate, or treat any specific disease. Furthermore, functional foods are managed under food safety rules rather than being classified as prescription pharmaceutical drugs.

4. (A) Supplements are sold in dose forms like powders or capsules
Dietary supplements are structurally distinguished from standard foods primarily by their delivery formats. They are prepared and marketed in measured dose forms such as capsules, tablets, powders, or liquids. While standard foods are consumed to satisfy hunger and provide basic daily caloric density, supplements deliver specific concentrated nutrients to support overall health.

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5. (D) Codex Alimentarius Commission
The Codex Alimentarius Commission is the principal international body established by the Food and Agriculture Organization and the World Health Organization to set global food standards. It develops harmonized guidelines for functional food labeling to protect consumer health and facilitate fair international trade, whereas regional bodies focus on their own national jurisdictions.

6. (B) Marketing products with unapproved disease risk reduction claims
Food safety regulators strictly prohibit marketing functional dairy products with unauthorized disease risk reduction claims. While probiotic strains can be validated and milk protein fractions standardized, making medical claims without rigorous regulatory approval leads to rejection. Ensuring compliance with authorized labeling rules is essential for protecting consumers from misleading or unproven therapeutic assertions.

7. (C) Products can replace medical therapies for chronic illness
Functional foods are designed to support physiological health and reduce disease risks, but they cannot replace established medical therapies for chronic illnesses. Regulatory standards require all ingredients to have documented safety records, meet strict microbiological criteria, and contain approved food additives within permissible limits. Promoting functional foods as direct substitutes for medical treatments is incorrect.

8. (D) The presence of purified bioactives conferring health benefits
The primary defining characteristic of a nutraceutical is the presence of purified bioactive components that deliver target physiological health benefits. While physical parameters like shelf life, sensory enhancement, or manufacturing overheads are important commercial factors in food science, they do not define the therapeutic and nutritional essence of a functional nutraceutical product.

9. (A) Injectable pharmaceutical antibiotics
Regulations governing health supplements and nutraceuticals specifically cover oral products like prebiotic foods, probiotic formulations, and foods for special dietary or medical purposes. Injectable pharmaceutical antibiotics fall strictly under drug regulations and are managed by pharmaceutical licensing bodies rather than food safety authorities, as they are medical interventions rather than dietary supplements.

10. (B) A nutrient claim describes the level of a nutrient, while a health claim describes its physiological effect
A nutrient content claim focuses entirely on describing the quantitative level or presence of a specific nutrient within a food product. In contrast, a health claim describes the relationship between that nutrient and its subsequent physiological effect on human health. Both claims require different levels of scientific substantiation and serve distinct regulatory purposes on labels.

11. (B) Colonic fermentation producing short-chain fatty acids
Dietary fibers interact beneficially with the host gut microbiome primarily because they escape digestion in the upper gastrointestinal tract. Upon reaching the colon, they undergo bacterial fermentation, which yields crucial short-chain fatty acids. This biochemical pathway supports the viability of beneficial bacteria, lowers colonic pH, and provides essential energy for intestinal epithelial cell survival.

12. (A) Neutralizing free radicals by donating an electron
The primary biochemical mechanism of an antioxidant in a food matrix involves neutralizing unstable free radicals by donating an electron. This single electron transfer stabilizes reactive oxygen species and halts the destructive chain reaction of lipid auto-oxidation, thereby protecting cellular components from oxidative stress and maintaining the nutritional quality of the food product.

13. (C) Butyrate
Butyrate is a key short-chain fatty acid produced during the bacterial fermentation of dietary fibers in the colon. It serves as the primary and preferred metabolic energy source for human colonocytes. This compound plays a critical physiological role in maintaining the integrity of the intestinal mucosal barrier, regulating gene expression, and suppressing local inflammatory responses.

14. (D) Soluble fiber is more fermentable by gut microbiota than insoluble fiber
Soluble dietary fiber possesses a chemical structure that makes it highly fermentable by beneficial gut microbiota compared to insoluble fiber. While soluble fiber forms viscous gels that can slow gastric emptying and lower cholesterol absorption, insoluble fiber primarily adds physical bulk to fecal matter, accelerating intestinal transit time and assisting in regular digestive elimination.

15. (C) A is true but R is false
Consuming foods rich in antioxidants reduces cellular oxidative stress by neutralizing reactive oxygen species. However, the claim that antioxidants act as catalysts to increase the production of these reactive oxygen species in cellular mitochondria is scientifically incorrect. Antioxidants function to suppress, rather than promote, the generation of harmful free radicals within cellular structures.

16. (B) Fructooligosaccharides
Fructooligosaccharides are non-digestible carbohydrates that act as prebiotics by selectively stimulating the growth and activity of beneficial colonic bacteria. In contrast, probiotic bacterial strains are live microorganisms, while compounds like alpha-tocopherol serve as antioxidants. Conjugated linoleic acid is classified as an active lipid, which does not meet the functional criteria of a prebiotic.

17. (D) Modulation of the microbiome to exclude intestinal pathogens
Consuming diets rich in non-starch polysaccharides modulates the gut microbiome, helping to exclude intestinal pathogens through competitive colonization. These complex carbohydrates undergo colonic fermentation, producing short-chain fatty acids that lower the local pH. This acidic environment inhibits pathogen survival, supports the mucosal lining, and avoids the rapid blood glucose spikes associated with simple sugars.

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18. (A) The microbiome profile remains static from birth
A common misconception regarding the human gut microbiome is that its composition remains completely static from birth. In reality, the microbial profile is highly dynamic and continually shaped by factors such as age, environment, antibiotic use, and dietary habits. Beneficial microbes also synthesize critical micronutrients, and structural imbalances in this community lead to dysbiosis.

19. (C) By terminating lipid peroxidation
Dietary antioxidants protect cell membranes by donating hydrogen atoms or electrons to free radicals, which effectively terminates the destructive lipid peroxidation chain reaction. This chemical neutralization preserves the structural integrity of membrane phospholipids, prevents oxidative damage to membrane-bound proteins, and protects cellular viability from the harmful effects of reactive oxygen species in the body.

20. (A) Altering host genetic sequences permanently
Modulating the gut microbiome using functional foods is designed to improve digestion, enhance immune responses, alleviate irritable bowel symptoms, and increase mineral absorption. However, this dietary intervention cannot permanently alter the host genetic sequences. Genetic modifications are beyond the physiological capabilities of gut microbiota, making this application irrelevant to functional food science.

21. (D) Alpha-tocopherol
Alpha-tocopherol is a naturally occurring, lipophilic antioxidant inherently present in bovine milk fat. It works to protect vulnerable milk lipids from oxidative degradation. Synthetic food-grade antioxidants like butylated hydroxytoluene or tertiary butylhydroquinone are artificial additives, and ascorbic acid is naturally found only in negligible concentrations in bovine milk, unlike this native fat-soluble vitamin.

22. (B) Probiotic and fermented milks
Probiotic and fermented milks represent the most dominant and rapidly growing segment in the global dairy nutraceuticals market. These products are highly valued by consumers for their digestive benefits and support of immune health. Other segments, such as low-lactose formulations or demineralized whey powder, serve specific niche dietary requirements rather than commanding the primary market share.

23. (C) Rising consumer awareness regarding preventive healthcare
The commercialization of dairy health foods in India is primarily driven by rising consumer awareness regarding preventive healthcare and wellness. As disposable incomes grow and lifestyle diseases become more prevalent, consumers increasingly seek functional dairy options with proven physiological benefits. This shift towards active wellness underpins the market demand, rather than regulatory bans or complete lactose eradication.

24. (D) Defining health benefits in the mind of the consumer
Market positioning for a novel functional dairy product involves defining its specific health benefits in the mind of the consumer. This marketing strategy distinguishes the product from standard commodities by highlighting its unique physiological value and scientific backing. It extends beyond simple physical shelf placement or pricing tactics to build brand trust and consumer loyalty.

25. (A) P-4, Q-3, R-2, S-1
Humanized infant formulas are designed for neonates to mimic mature breast milk. Plant-sterol enriched yogurts target individuals with cardiovascular risks by helping lower cholesterol. High-branched-chain amino acid whey isolates are utilized by athletes for muscle recovery. Calcium-fortified, highly digestible milks are designed for the geriatric population to support bone health and ease digestion.

26. (B) Aging and post-menopausal women
Aging and post-menopausal women are the primary demographic driving the global demand for bone-health dairy nutraceuticals. Estrogen decline during menopause accelerates bone density loss, increasing osteoporosis risks. Fortified dairy foods rich in calcium, vitamin D, and bioactive peptides offer an effective, accessible dietary strategy to support skeletal maintenance and slow down age-related bone mineral depletion.

NODIA

(D) IE requires the use of strong chemical acids and bases for the regeneration of the resin beds

2004

194. What is the direct cause of severe "fouling" in a nanofiltration plant processing raw acid whey?
(A) The complete and total lack of all active mineral compounds in the raw acid whey
(B) The precipitation of calcium phosphate and protein deposition on the membrane pores
(C) The intense electrical current directly melting the commercial polymer membrane
(D) The rapid and continuous generation of pure distilled water inside the system

2024

195. Arrange the following processing steps in the correct order to maximize the demineralization efficiency of highly salty cheese whey:
I. Nanofiltration for pre-concentration and partial monovalent ion removal
II. Electrodialysis or Ion Exchange for deep, comprehensive demineralization
III. Clarification and fat separation of raw whey
IV. Spray drying of the demineralized concentrate
(A) I → II → III → IV
(B) III → I → II → IV
(C) II → III → I → IV
(D) III → II → I → IV

2018

196. Which of the following technologies is NOT effective for the demineralization of whey?
(A) HTST pasteurization
(B) Electrodialysis
(C) Nanofiltration
(D) Ion exchange

2024

197. In comparing network techniques, what is a primary environmental or operational disadvantage of strict ion exchange compared to electrodialysis?
(A) Ion exchange utilizes absolutely no electrical power or current during standard runs
(B) Ion exchange completely and permanently destroys the nutritional lactose disaccharide
(C) Ion exchange generates large volumes of acidic and basic wastewater during resin regeneration
(D) Ion exchange is highly restricted, processing only one liter of whey per production day

2022

198. Which specific classification accurately describes nanofiltration in the context of membrane separation?
(A) A pressure-driven membrane process between reverse osmosis and ultrafiltration
(B) A purely thermal-based evaporation process utilizing high-temperature steam
(C) A static settling and sedimentation process driven solely by natural gravity
(D) A biological yeast or bacterial fermentation process under anaerobic states

2010

199. How is "sweet buttermilk" defined in dairy processing terminology?
(A) Milk that has been intentionally and heavily sweetened with refined sucrose
(B) Whey that has been completely neutralized by adding strong sodium hydroxide
(C) Raw milk sourced exclusively from dairy cows fed a specialized high-sugar diet
(D) The aqueous byproduct from churning fresh, unfermented sweet cream into butter

2004

200. Consider the following statements regarding the compositional chemistry of true sweet buttermilk:
I. It possesses a drastically higher concentration of the Milk Fat Globule Membrane (MFGM) compared to whole milk.
II. It is incredibly rich in functional phospholipids like phosphatidylcholine.
III. It contains absolutely zero lactose.
IV. Its total protein content is roughly equivalent to standard skim milk.
Which of the above statements are correct?
(A) I, II, and IV
(B) I, III, and IV
(C) II, III, and IV
(D) I and II only

2023

201. Which specific chemical process characterizes the definitive origin of "sour buttermilk"?
(A) The direct chemical addition of physical whole milk with sulfuric acid
(B) The physical spoilage of raw milk strictly by psychrotrophic bacteria
(C) The churning of cream fermented by lactic acid-producing starter cultures
(D) The boiling of sweet buttermilk until it turns sour via thermal reactions

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are derived from beta-casein, lactokinins come from whey proteins, and lactoferricin is cleaved from lactoferrin rather than beta-lactoglobulin. This makes the pairing of kappa-casein and glycomacropeptide correct.

36. (A) They suppress the immune system entirely
Whey-derived bioactive peptides do not suppress the immune system entirely; instead, they function as immunomodulators that help regulate immune responses. They stimulate lymphocyte proliferation, enhance macrophage phagocytosis, and coordinate cytokine secretion. This active regulation helps maintain balanced immune defenses, protecting the body against pathogenic infections without causing complete systemic immune suppression.

37. (D) Beta-casomorphin
Beta-casomorphin is a bioactive peptide derived from beta-casein that is renowned for its opioid-like agonist activity. This peptide can bind to opioid receptors in the central nervous and gastrointestinal systems, influencing intestinal transit times and exhibiting calming physiological effects. Other peptides like lactokinin, lactoferricin, or caseinophosphopeptides do not display these specific opioid receptor-binding properties.

38. (B) They bind minerals like calcium, enhancing absorption
Caseinophosphopeptides function in human nutrition by binding minerals, particularly divalent calcium, to prevent their precipitation in the alkaline environment of the small intestine. This biochemical binding maintains calcium in a soluble form, enhancing its bioavailability and absorption. They do not inhibit digestive enzymes, trigger systemic allergic reactions, or degrade beneficial fatty acids in the gut.

39. (C) Gastric hydrolysis → Pancreatic digestion → Intestinal absorption → Systemic circulation
The in vivo generation and utilization of bioactive peptides from milk consumption begins with gastric hydrolysis in the stomach, followed by pancreatic digestion in the small intestine. This enzymatic activity releases the active peptides from their parent proteins. The liberated peptides then undergo intestinal absorption and enter systemic circulation to exert their physiological effects.

40. (B) II and IV
Bioactive peptides are generated through both bacterial fermentation and digestive enzyme action, and they are generally stable during standard heat treatments. They remain inactive within the parent protein sequence and typically range from 2 to 20 amino acids in length. Therefore, asserting they can only be generated via fermentation and are highly heat-susceptible is incorrect.

41. (A) Cholesterol synthesis
Whey-derived bioactive peptides are recognized for multiple health benefits, including antimicrobial activity, satiety induction, and antioxidant properties. However, promoting cholesterol synthesis is not a physiological benefit of these compounds. Scientific evidence shows that certain dairy peptides actually help lower cholesterol levels, making the promotion of cholesterol synthesis an incorrect characterization of their functional roles.

NODIA

42. (B) Lactoferricin is a peptide cleaved from intact lactoferrin
Lactoferricin is a highly potent antimicrobial peptide that is biochemically cleaved from the N-terminal region of intact lactoferrin during gastric digestion by pepsin. Unlike the large, multi-domain parent glycoprotein lactoferrin, lactoferricin is a smaller peptide fragment. It maintains strong, independent physiological activities, especially against a wide range of pathogenic microorganisms.

43. (B) cis-9, trans-11 CLA
The cis-9, trans-11 isomer, also known as rumenic acid, is the most abundant conjugated linoleic acid isomer found naturally in ruminant milk fat. It is produced through the biohydrogenation of dietary polyunsaturated fatty acids by rumen microflora. This specific isomer is widely studied for its anti-carcinogenic, anti-inflammatory, and overall health-promoting properties.

44. (A) A sphingosine base
Sphingolipids found within the milk fat globule membrane are structurally defined by a sphingosine backbone, which distinguishes them from glycerol-based phospholipids. This lipid class, including sphingomyelin, plays an important physiological role in cellular signaling, neural membrane development, and the

maintenance of a healthy gut mucosal barrier in the human body.

45. (C) Supplementing diets with extruded flaxseed or algae
Supplementing the diets of lactating dairy cows with extruded flaxseed, linseed, or marine algae effectively enriches bovine milk with omega-3 polyunsaturated fatty acids. These feed ingredients are rich in alpha-linolenic acid, eicosapentaenoic acid, and docosahexaenoic acid, which bypass complete ruminal biohydrogenation to be incorporated directly into the synthesized milk fat.

46. (D) Incomplete biohydrogenation of dietary unsaturated fatty acids
Conjugated linoleic acid is produced in ruminants primarily through the incomplete biohydrogenation of dietary unsaturated fatty acids, such as linoleic and linolenic acids, by rumen microorganisms. This intermediate biochemical pathway, along with endogenous conversion of vaccenic acid in the mammary gland, yields beneficial fatty acids that are subsequently incorporated into the milk fat.

47. (C) It serves as a structural component in brain development
Dietary sphingomyelin from milk acts as a crucial structural component in the development of brain and nervous tissue, particularly in supporting myelination. Scientific research indicates that sphingolipids do not promote colorectal cancer, block vital nutrient absorption, or degrade into harmful free radicals; instead, they support cognitive function and gut membrane integrity.

48. (B) A significant extension of the milk's ambient shelf life without antioxidants
Enriching milk with omega-3 fatty acids increases its susceptibility to oxidative rancidity and off-flavor development due to the high number of double bonds. This enrichment does not extend the milk's shelf life without antioxidant protection. Proper encapsulation or the addition of antioxidants is necessary to maintain stability and prevent sensory defects in the final product.

49. (D) Pasture grasses contain alpha-linolenic acid, a CLA precursor
Pasture-fed cows produce milk with higher levels of conjugated linoleic acid because fresh pasture grasses are naturally rich in alpha-linolenic acid, which acts as a key biochemical precursor for CLA synthesis. In contrast, stall-fed cows typically receive grain concentrates lower in these specific precursor fatty acids, resulting in lower CLA levels in their milk.

50. (A) Conjugated Linoleic Acid
Conjugated Linoleic Acid is a functional milk lipid that has been extensively researched for its potential to inhibit adipogenesis and modify body composition. Clinical and animal studies suggest that specific isomers of this fatty acid can help reduce adipose tissue accumulation and support lean body mass, making it a valuable target in functional food development.

51. (C) To stabilize lipid droplets in milk and prevent coalescence
The primary biological function of the milk fat globule membrane in raw milk is to stabilize synthesized lipid droplets within the aqueous phase, preventing their coalescence and subsequent creaming. This unique membrane structure also acts as a physical barrier that protects the core triglycerides from enzymatic degradation by native milk lipases.

52. (A) They are synthesized abundantly de novo within the body
Omega-3 fatty acids like eicosapentaenoic acid and docosahexaenoic acid are essential nutrients that cannot be synthesized abundantly de novo by the human body; they must be obtained through the diet. These polyunsaturated fatty acids are highly susceptible to lipid peroxidation, but they play a protective role in cardiovascular health and possess anti-inflammatory properties.

53. (D) It acts as a precursor, endogenously converting to CLA
Vaccenic acid is a trans fatty acid naturally occurring in ruminant fats that serves as a key physiological precursor for conjugated linoleic acid. Upon consumption, vaccenic acid is endogenously converted into cis-9, trans-11 CLA via the action of the delta-9 desaturase enzyme in human tissues, thereby contributing to the health benefits associated with CLA.

54. (B) Chelation of free iron, depriving bacteria of nutrients
Bovine lactoferrin exerts its primary antimicrobial action by chelating free iron in the surrounding environment, which deprives

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iron-dependent pathogenic bacteria of an essential nutrient required for their growth and replication. This iron-binding mechanism inhibits bacterial proliferation, particularly affecting Gram-negative bacteria that rely heavily on environmental iron availability for survival.

55. (C) A is true but R is false
The lactoperoxidase system can be activated to extend the shelf life of raw milk in areas lacking refrigeration, as it produces antimicrobial intermediates that inhibit bacterial growth. However, the explanation that lactoperoxidase functions by denaturing all milk proteins is false; it operates through an enzymatic pathway that preserves proteins while targeting bacterial cells.

56. (D) Lactoperoxidase, peroxide, and thiocyanate
Activating the lactoperoxidase antimicrobial system in milk requires three essential components: the native lactoperoxidase enzyme, hydrogen peroxide, and thiocyanate ions. When these elements are present, the enzyme catalyzes the oxidation of thiocyanate by hydrogen peroxide, producing short-lived antibacterial compounds like hypothiocyanite that temporarily inhibit bacterial growth.

57. (A) They easily survive ultra-high temperature processing
Bovine immunoglobulins are biologically active proteins that are highly sensitive to heat and do not survive ultra-high temperature processing. While they are concentrated in colostrum to provide passive immunity to newborn calves and can target gut pathogens in humans, severe heat treatments denature their structural conformation, resulting in a loss of their protective immunological functions.

58. (B) They serve as prebiotics, stimulating gut bifidobacteria
Bovine milk oligosaccharides serve as prebiotics that selectively stimulate the growth and metabolic activity of beneficial gut bacteria, particularly Bifidobacterium species. These complex carbohydrates resist gastric acidity and host enzymatic digestion in the upper gastrointestinal tract, enabling them to reach the colon intact, where they support a balanced and healthy microbiome.

59. (B) Lysozyme
Lysozyme is a minor milk protein that exhibits direct muramidase activity, allowing it to hydrolyze the beta-1,4-glycosidic bonds between N-acetylmuramic acid and N-acetylglucosamine in bacterial peptidoglycan. This enzymatic action breaks down the cell walls of Gram-positive bacteria, leading to cell lysis and providing a natural protective barrier against microbial infections.

60. (A) I and III
Lactoferrin is isolated using cation exchange chromatography due to its high isoelectric point, and colostrum is the most viable commercial source for extracting bovine immunoglobulins. However, bovine milk oligosaccharides are highly concentrated in early colostrum rather than late mature milk, and lactoperoxidase is an enzymatic protein rather than a lipid-based molecule.

61. (C) BMOs have lower structural diversity and concentration than HMOs
Bovine milk oligosaccharides have lower structural diversity and are present in significantly lower concentrations in mature milk compared to human milk oligosaccharides. Human milk contains highly complex, diverse, and abundant oligosaccharide structures designed to support the developing infant. This structural difference requires careful formulation when utilizing bovine-derived oligosaccharides in human infant formulas.

62. (D) Thermal load during spray drying causing denaturation
The primary cause of activity loss in functional immunoglobulins during the commercial production of milk powders is the thermal load experienced during the spray drying process. The high temperatures can denature these heat-sensitive proteins, disrupting their specific three-dimensional structures and reducing their capability to bind target pathogens in the gastrointestinal tract.

63. (C) Emulsification of lipids
Lactoferrin is recognized for several biological functions, including antiviral activity, bone growth stimulation, and immune modulation. However, the emulsification of lipids is not a primary biological property of lactoferrin. Emulsification in milk is handled by proteins like caseins and the specialized phospholipids of the

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production, which can alter the physical texture of the gel and cause gastrointestinal discomfort for consumers. This occurs due to rapid bacterial fermentation of the prebiotic carbohydrates in the gut, requiring careful dosage optimization to balance functionality and sensory appeal.

84. (A) Aspartame
Aspartame is a high-intensity artificial sweetener that does not function as a prebiotic because it is a dipeptide that is rapidly metabolized in the small intestine rather than undergoing selective fermentation in the colon. In contrast, xylooligosaccharides, trans-galactooligosaccharides, and pectin are non-digestible carbohydrates that meet the criteria of prebiotics.

85. (A) II → IV → I → III
Integrating botanical extracts into a pasteurized dairy beverage begins with extracting active phytochemicals from the herb. Next, the extract is blended into the raw milk matrix, followed by homogenization of the mixture to ensure uniform distribution. Finally, thermal pasteurization is applied to secure microbiological safety while preserving the active compounds.

86. (B) An active, non-nutrient plant compound conferring benefits
A phytochemical is defined as a biologically active, non-nutrient compound found naturally in plants that provides health benefits to humans when consumed. These compounds, such as polyphenols, flavonoids, and carotenoids, act through antioxidant, anti-inflammatory, or immunomodulatory pathways to support wellness, distinguishing them from essential macronutrients or synthetic additives.

87. (C) Curcumin's inherent lipophilicity and poor aqueous solubility
The primary technical challenge when incorporating curcumin into an aqueous milk beverage is its strong lipophilicity and very poor solubility in water. This causes curcumin to precipitate out of the liquid phase, leading to uneven distribution and sedimentation. Addressing this requires encapsulation, emulsification, or utilizing milk fat to help stabilize the bioactive compound.

88. (D) Botanical integration uniformly extends the shelf-life of dairy products without exception
Botanical integration does not uniformly extend the shelf life of dairy products without exception. While some herbs contain antimicrobial compounds, others can introduce microbiological contaminants, promote physical instability, or alter sensory properties. Factors such as protein-polyphenol interactions, thermal degradation of volatile compounds, and the need for flavor-masking must be carefully managed.

89. (A) Withanolides
Withanolides are the primary active steroidal lactones responsible for the adaptogenic and health-promoting properties of Ashwagandha when incorporated into therapeutic dairy formulations. These phytochemicals help the body adapt to stress, support immune health, and provide anti-inflammatory benefits, distinguishing them from other botanical bioactives like curcuminoids, ginsenosides, or catechins.

90. (B) II and IV
Milk proteins do not strictly inhibit all phytochemical absorption, nor does encapsulation destroy the bioactivity of essential oils; instead, encapsulation protects volatile compounds. While milk fat can shield lipophilic bioactives during digestion and phenolic compounds can introduce astringency, claiming complete inhibition of absorption or destruction of bioactivity is incorrect in dairy science.

91. (B) They form insoluble complexes, potentially reducing antioxidant capacity
Polyphenol-protein interactions in a dairy matrix can lead to the formation of insoluble complexes, which may reduce the bioavailability and antioxidant capacity of the added phytochemicals. This binding occurs between milk proteins, particularly caseins, and polyphenols, affecting both the physical stability of the beverage and the nutritional efficacy of the bioactive compounds.

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92. (A) Encapsulation of the botanical extract prior to blending
Encapsulating the botanical extract before blending it into dairy formulations is an effective technological method for masking the bitter, undesirable flavors of certain therapeutic herbs. This process coats the bioactive compounds in a

overgrowth. Probiotic intervention helps rebuild a balanced microbial community, helping to reduce diarrheal symptoms.

74. (B) Milk proteins provide buffering shielding probiotics during transit
A fermented dairy matrix like yogurt is an excellent vehicle for probiotics because milk proteins provide a buffering effect that shields the bacteria from gastric acid during digestive transit. This protective buffer increases the survival rate of probiotics as they pass through the stomach, helping a greater number of viable cells reach the colon.

75. (B) It must resist host digestion and stimulate beneficial gut bacteria
To be classified as a prebiotic, a substance must resist host salivary and upper gastrointestinal digestion, passing intact into the colon. There, it must serve as a selective substrate that stimulates the growth or metabolic activity of beneficial bacteria, such as bifidobacteria and lactobacilli, thereby supporting host health.

76. (A) A polymer of fructofuranosyl units terminating in a glucose
Inulin is a dietary prebiotic structurally defined as a polydisperse carbohydrate polymer consisting of beta-2,1-linked fructofuranosyl units, typically terminating in a single D-glucose molecule. This specific chemical structure prevents hydrolysis by human digestive enzymes, allowing inulin to reach the colon intact, where it undergoes selective bacterial fermentation.

77. (C) Through transgalactosylation of lactose by beta-galactosidase
Galactooligosaccharides are commercially produced through the enzymatic transgalactosylation of lactose using the enzyme beta-galactosidase. This reaction links galactose units together to form prebiotic oligosaccharides of varying chain lengths. This process utilizes dairy-derived lactose as a starting material to synthesize functional, non-digestible carbohydrates for prebiotic applications.

78. (D) A blend of probiotic and prebiotic enhancing survival and colonization
A synbiotic dairy product is defined as a formulation combining probiotics and prebiotics that works synergistically to enhance the survival, implantation, and activity of beneficial microorganisms in the host gut. This combination supports the viability of the probiotic strain during storage and digestive transit, optimizing its positive effects on gastrointestinal health.

79. (C) They increase only the product's caloric density
Fructooligosaccharides do not simply increase the caloric density of fermented milks; instead, they function as prebiotics that selectively promote beneficial bacteria, improve texture, and provide a mild sweetening effect. Because they resist human digestion, they contribute fewer calories than standard sucrose, making them useful for formulating low-fat, health-focused dairy products.

80. (A) P-3, Q-1, R-2, S-4
Inulin is obtained commercially through extraction from chicory roots. Galactooligosaccharides are synthesized via the enzymatic transgalactosylation of lactose. Lactulose is produced through the chemical isomerization of lactose. Fructooligosaccharides are produced either by the enzymatic hydrolysis of inulin or through synthesis from sucrose molecules, matching the listed prebiotic sources.

81. (D) Prebiotic fermentation yields SCFAs, lowering pH and dissolving calcium
Prebiotic consumption increases calcium absorption because the fermentation of prebiotics by colonic bacteria yields short-chain fatty acids. This production lowers the localized pH of the colon, which increases the solubility and dissolution of mineral calcium, facilitating its passive transport and absorption across the intestinal epithelial barrier.

82. (A) Inulin has a higher DP, providing more texturizing properties
Inulin has a higher average degree of polymerization compared to short-chain fructooligosaccharides, which gives it distinct texturizing properties and allows it to act as a fat replacer in food matrices. In contrast, short-chain fructooligosaccharides have a lower degree of polymerization, offering greater solubility and a sweeter taste profile.

83. (C) Excessive gas production altering texture and causing discomfort
Formulating synbiotic yogurts with high dosages of prebiotics can lead to excessive gas

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to ensure uniform distribution of the vitamin throughout the finished product.

103. (C) Vitamin D is highly volatile and rapidly lost during standard refrigeration
Vitamin D is a fat-soluble compound that is stable under standard cold storage conditions; it is not volatile and is not rapidly lost during refrigeration. In contrast, Vitamin A is light-sensitive, riboflavin degrades under ultraviolet light exposure, and ascorbic acid is easily oxidized during thermal processing, making the assertion about Vitamin D incorrect.

104. (D) It prevents iron from interacting with lipids and proteins
Microencapsulated iron is preferred in fortified milk powders because the protective coating prevents free iron from interacting with milk lipids and proteins. This physical barrier stops the iron from catalyzing lipid oxidation, which avoids metallic off-flavors and discoloration, while maintaining the nutrient's bioavailability for absorption in the gut.

105. (B) II → III → IV → I
The correct processing sequence for liquid milk fortification begins with standardizing the milk's fat and solids-not-fat. Next, the vitamin premix is added to the standardized milk, followed by homogenization to ensure even distribution of the nutrients. Finally, flash pasteurization is applied to secure microbiological safety while minimizing nutrient loss.

106. (B) Modifying milk's nutrient profile to match human breast milk
The primary objective in the humanization of bovine milk for infant formulas is to modify its nutrient profile to match human breast milk. This process involves adjusting the protein, lipid, carbohydrate, and mineral concentrations to meet the physiological requirements and digestive capacities of developing infants, rather than adding human DNA or replacing all proteins.

107. (C) 60:40
Standard stage 1 infant formulas aim for a whey protein to casein ratio of approximately 60:40, which mimics the protein composition of mature human breast milk. In contrast, unmodified bovine milk has a ratio of about 20:80, which is harder for infants to digest and can lead to excessive renal solute load.

108. (A) It has a high renal solute load and lacks essential fatty acids
Unmodified cow's milk is unsuitable for direct consumption by human neonates because its high protein and mineral content creates an excessive renal solute load that can stress immature kidneys. Additionally, it lacks sufficient levels of essential fatty acids, iron, and specific vitamins required for proper infant growth and cognitive development.

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109. (C) Tryptophan
Tryptophan is an essential amino acid commonly added to infant formulas because bovine whey protein contains lower levels of it compared to human breast milk. Ensuring adequate tryptophan is necessary for supporting healthy protein synthesis, sleep regulation, and cognitive development in growing infants, making amino acid profile adjustment essential in formula design.

110. (B) I, II, and IV
Infant formula regulations strictly prohibit artificial colors, set clear limits for energy density, and require iron fortification to prevent anemia in infants. However, formulas must contain carbohydrates like lactose to support growth, and there is zero tolerance for pathogenic bacteria, making the assertions regarding zero carbohydrates and permissible pathogen levels incorrect.

111. (C) It removes minerals like sodium and potassium to lower renal solute load
Electrodialysis is used in infant formula production to remove excess minerals, such as sodium and potassium, from whey. This demineralization process lowers the renal solute load of the formulation, protecting the immature kidneys of infants from osmotic stress and bringing the mineral profile closer to that of human breast milk.

112. (B) The modification is performed to mimic the fatty acid profile of raw cow's milk
Lipid modification in infant formulas is performed to mimic the fatty acid profile of human breast milk, not raw cow's milk. Bovine milk fat is replaced with vegetable oil blends to provide essential fatty acids, and arachidonic

protective carrier matrix, preventing their direct contact with taste receptors during consumption while preserving their stability and health benefits.

93. (C) Belladonna
Belladonna is highly toxic and is not used in commercial fusion dairy health foods due to safety risks and a lack of regulatory approval. While botanicals like Tulsi, Brahmi, and turmeric are widely approved and integrated for their health benefits, Belladonna contains toxic alkaloids that pose severe health hazards, excluding it from food formulations.

94. (D) Flavonoids
Catechins and anthocyanins belong to the flavonoids, a major class of polyphenolic phytochemicals widely used in functional foods. These compounds are studied for their antioxidant, anti-inflammatory, and cardiovascular benefits. Their chemical structures contain phenolic rings that allow them to scavenge free radicals, distinguishing them from other categories like alkaloids or terpenes.

95. (A) Both A and R are true and R is the correct explanation of A.
Adding soluble iron salts to liquid milk can accelerate the development of oxidized off-flavors because iron acts as a potent pro-oxidant catalyst for the auto-oxidation of unsaturated milk lipids. This catalytic activity generates free radicals that break down fatty acids into volatile compounds, causing metallic and cardboard-like sensory defects in the dairy product.

96. (B) Fortification adds new nutrients; enrichment restores lost nutrients
Fortification is defined as the practice of deliberately increasing the content of essential micronutrients in a food, irrespective of whether the nutrients were originally present. In contrast, enrichment refers to the physical addition of nutrients back to a food product to restore levels that were lost during commercial processing operations.

97. (D) Cholecalciferol
Cholecalciferol, also known as Vitamin D3, is the mandated chemical source for fortifying milk under standard food safety regulations. It is preferred for its stability, bioavailability, and efficiency in supporting calcium absorption. Regulatory frameworks specify this form to ensure consistency and efficacy in public health programs targeting bone mineral density.

98. (A) Ferric pyrophosphate
Ferric pyrophosphate is an iron fortificant that causes minimal lipid oxidation and color change in dairy products, making it useful for liquid milk and milk powder formulations. Because of its low solubility in water, it does not interact strongly with proteins or lipids, though this insolubility also results in lower relative bioavailability.

99. (C) Calcium fortification always increases the bioavailability of co-ingested iron
Calcium fortification does not increase the bioavailability of co-ingested iron; instead, high levels of calcium can competitively inhibit iron absorption in the human gut. While soluble calcium salts can destabilize caseins and insoluble forms like tricalcium phosphate require stabilizers to stay suspended, asserting that calcium enhances iron absorption is incorrect.

100. (A) P-3, Q-4, R-1, S-2
Vitamin A is highly susceptible to photo-oxidation, requiring protective packaging. Iron acts as a catalyst for lipid oxidation, causing metallic off-flavors. Vitamin C is highly sensitive to thermal degradation during pasteurization. Calcium fortification can cause protein precipitation and casein micelle destabilization, summarizing the key formulation challenges associated with these nutrients.

101. (D) Vitamin D enhances active transport of calcium in enterocytes
Fortifying dairy products with Vitamin D alongside calcium improves calcium absorption by enhancing its active transport across enterocytes in the small intestine. Vitamin D upregulates the expression of calcium-binding proteins, such as calbindin, ensuring efficient uptake of dietary calcium and supporting bone mineralization, rather than inhibiting absorption or precipitating the mineral.

102. (B) Vitamin A — Retinyl palmitate
Retinyl palmitate is the ester form of Vitamin A commonly used for milk fortification because of its stability in fat-containing dairy products compared to free retinol. This fat-soluble form blends evenly with the milk fat phase during standardization and homogenization, helping

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enables the pre digestion of proteins. Malting activates endogenous amylases to reduce food viscosity, and drum drying yields instantized flake structures. Together, these processes optimize the physical texture, ease of preparation, and nutritional digestibility of infant cereals.

123. (A) Twin-screw extruders offer superior mixing, control, and moisture versatility
Twin screw extrusion offers a clear technological advantage over single screw systems due to its superior mixing capability, precise temperature control, and high operational versatility with varying moisture levels. This allows manufacturers to efficiently process complex milk cereal formulations, producing high quality complementary foods with consistent physical expansion, starch gelatinization, and nutrient preservation.

124. (B) Skim milk powder — Supply of high biological value protein and calcium
Skim milk powder is highly valued in the formulation of weaning foods because it provides exceptionally high biological value proteins and essential bioavailable calcium. These nutrients are absolutely critical for structural bone development, muscle deposition, and general cellular growth in developing infants, making dairy solids a premier choice for boosting the nutrient profile of cereal complementary foods.

125. (B) Incorporating Clostridium botulinum spores to build early immunity
Incorporating Clostridium botulinum spores into infant foods is strictly prohibited and extremely hazardous. Infant digestive systems are immature, lacking the protective gut microbiota required to prevent these spores from germinating and producing lethal botulinum neurotoxins. Safety guidelines require complete absence of these bacterial spores, heavy metals, and aflatoxins to protect infant health.

126. (A) To achieve amino acid complementarity where milk lysine balances deficient cereals
Blending dairy proteins with cereal proteins achieves excellent amino acid complementarity. Most cereals are naturally deficient in lysine, an essential amino acid required for infant growth, while dairy proteins are highly abundant in lysine. Combining these sources balances the overall amino acid profile, maximizing the protein efficiency ratio and supporting healthy muscle and tissue development.

127. (C) Dry blended instant infant cereals
Dry blended instant infant cereals are manufactured by physically mixing pre cooked, roller dried milk powder with toasted cereal flours without any additional thermal steps. This straightforward, efficient process yields a highly convenient, stable product that reconstitutes rapidly in warm water or milk, maintaining high nutrient retention and excellent physical dispersion when prepared at home.

128. (D) The age-related, progressive loss of skeletal muscle mass and function
Sarcopenia is defined as the age related, progressive loss of skeletal muscle mass, strength, and physical function. Geriatric dairy foods are specifically designed to address this chronic physiological decline by delivering highly concentrated, bioavailable proteins and branched chain amino acids, which stimulate muscle protein synthesis and preserve functional mobility in the elderly population.

129. (C) Elderly individuals experience "anabolic resistance," requiring a higher per-meal protein dose to stimulate muscle protein synthesis
Elderly individuals require higher protein intake because they experience anabolic resistance, a state where aging muscles show reduced sensitivity to lower circulating levels of amino acids. To overcome this resistance and effectively trigger muscle protein synthesis, older adults require a larger per meal dose of high quality, leucine rich proteins than younger cohorts.

130. (A) Both (A) and (R) are true and (R) is the correct explanation of (A).
Adding dietary fiber and prebiotics to geriatric dairy formulations is highly beneficial because the elderly frequently experience decreased intestinal motility and altered gut microbiota. Incorporating these functional ingredients actively stimulates beneficial bifidobacteria growth, enhances gastrointestinal health, improves regular bowel function, and assists in the overall absorption of vital micro and macro nutrients.

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and docosahexaenoic acids are added to support development, using emulsifiers like lecithin for stability.

113. (D) The kidneys must excrete large volumes of water, risking dehydration
If an infant formula has an excessively high renal solute load, the infant's immature kidneys must excrete large volumes of water to eliminate the excess minerals and protein byproducts. This osmotic strain increases the risk of dehydration, highlighting the importance of demineralizing whey and adjusting protein ratios in formula production.

114. (A) Alpha-lactalbumin
Alpha-lactalbumin is a dominant whey protein in human milk that is enriched in premium infant formulas. This protein has a favorable amino acid profile, rich in tryptophan and cysteine, and is easy to digest, helping to reduce the overall protein content of formulas while meeting the nutritional needs of infants.

115. (C) The proteins are enzymatically cleaved into smaller peptides
Hypoallergenic or hydrolyzed infant formulas are distinguished by having their proteins enzymatically cleaved into smaller peptides. This structural reduction minimizes the presence of large, intact protein allergens that can trigger immune responses in sensitive infants, making these formulas easier to digest for infants with diagnosed cow's milk protein allergies.

116. (A) Artificial non-nutritive sweeteners
Codex Alimentarius guidelines strictly prohibit or restrict the use of artificial non nutritive sweeteners in standard infant formula formulations. These regulations ensure that infants receive only safe, nutrient dense ingredients suitable for their rapid growth. Sweeteners are excluded to prevent metabolic issues and maintain the nutritional integrity of products designed for this vulnerable age group.

117. (C) A transitional food introduced when milk is no longer sufficient for nutritional needs
A weaning food is specifically defined as a transitional nutritional source introduced to infants when breast milk or formula alone is no longer sufficient to meet their expanding physiological and energy needs. This typically occurs around six months of age, assisting in the safe transition toward solid foods while supporting healthy infant growth and developmental milestones.

118. (A) Amylase-rich flour addition or malting
The addition of amylase rich flour or malting is a highly effective processing technique used to lower dietary bulk and starch viscosity in weaning foods. This process involves activating endogenous or exogenous amylase enzymes to break down complex starches into simpler sugars, enhancing nutritional density and making the food easier for young infants to digest.

119. (D) By gelatinizing starches and reducing anti-nutritional factors
Extrusion cooking significantly improves the nutritional profile of dairy cereal complementary foods by gelatinizing starches and reducing anti nutritional factors such as trypsin inhibitors. This high temperature short time physical treatment enhances digestibility, increases nutrient bioavailability, inactivates unwanted food enzymes, and sanitizes the final product, making it safer and more palatable for infants.

120. (B) High levels of raw, intact dietary fiber are highly recommended to prevent infant diarrhea
Formulating complementary foods requires minimizing high levels of raw intact dietary fiber because infants have a very small gastric capacity. Excess fiber increases bulk, reduces calorie density, and interferes with the absorption of essential minerals like iron and zinc. Highly digestible, soft, and nutrient dense matrices are preferred to support safe infant feeding and rapid physical growth.

121. (C) The thermal reaction of reducing sugars with free amino groups
The drum drying of milk cereal blends often leads to Maillard browning due to the heat induced thermal reaction between reducing sugars and free amino groups of proteins. This non enzymatic reaction is accelerated by high temperatures and moisture content during drying, which alters the product color, generates unique flavor compounds, and potentially decreases lysine bioavailability.

122. (D) P-2, Q-1, R-4, S-3
In complementary food processing, high shear extrusion is matched with starch gelatinization and texturization, while protease addition

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milk fat globule membrane rather than this iron-binding glycoprotein.

64. (B) Live microorganisms conferring a health benefit in adequate amounts
Under internationally recognized guidelines, probiotics are defined as live microorganisms that, when administered in adequate amounts, confer a health benefit on the host. This definition requires that the strains remain viable at the point of consumption, possess proven safety profiles, and demonstrate clinically validated efficacy in supporting digestive or immune functions.

65. (D) Resistance to human gastric acidity and bile toxicity
A key physiological criterion for selecting a commercial probiotic strain is its ability to survive transit through the human digestive tract, which requires resistance to gastric acidity and bile toxicity. Probiotics must survive these stomach and small intestine environments to reach the colon in sufficient numbers to exert their beneficial health effects.

66. (A) They are strictly aerobic organisms thriving in high oxygen environments
The genus Bifidobacterium consists of anaerobic or microaerophilic bacteria that are sensitive to high oxygen levels. They are not strictly aerobic organisms. They naturally colonize the infant gut, utilize prebiotic oligosaccharides for fermentation, and often exhibit a branched, Y-shaped morphology, which makes oxygen exposure a challenge during dairy processing.

67. (C) 10^6 to 10^7 CFU/g
To justify a valid health claim, probiotic dairy products are generally required to maintain a minimum viable count of 10^6 to 10^7 colony-forming units per gram at the end of their commercial shelf life. This concentration is necessary to deliver an effective dose of live bacteria to support intestinal health upon consumption.

68. (A) It leads to loss of viable probiotic counts and excessive sourness
Over-acidification during the refrigerated storage of probiotic yogurt causes a decrease in viable probiotic counts and creates an excessively sour taste. This post-acidification occurs due to the continuous metabolic activity of starter cultures, which produces lactic acid, lowers the pH, and reduces the survival of sensitive probiotic strains.

69. (D) Microencapsulation of cells within biopolymer matrices like alginate
Microencapsulation of cells within protective biopolymer matrices, such as alginate or chitosan, is an effective technological intervention used to preserve probiotic viability. This technique shields the bacteria from harsh environmental factors, processing stresses, and gastric acidity, allowing for targeted release and colonization in the human intestinal tract.

70. (C) II and III
Valid probiotic health claims must be substantiated by robust, strain-specific human clinical trials. Probiotic strains are also widely recognized for helping to alleviate the symptoms of lactose intolerance by providing bacterial beta-galactosidase. However, regulations strictly prohibit claims that guarantee the absolute prevention or cure of any infectious disease.

71. (A) Both A and R are true and R is the correct explanation of A.
Lactobacillus acidophilus is commonly used in commercial probiotic milk formulations because of its robust health profile. This strain possesses strong intrinsic resistance to host bile salts and gastric acidity, enabling it to survive transit through the upper gastrointestinal tract and effectively colonize the colon to deliver digestive benefits.

72. (D) Direct destruction of host enterocytes to access blood nutrients
Probiotics support gut health by producing bacteriocins, enhancing epithelial barrier integrity, and competitively adhering to the mucosa to block pathogens. They do not destroy host enterocytes to access nutrients, as this would cause tissue damage and promote infection, which is contrary to their characterized role as beneficial microorganisms.

73. (A) To restore native gut microbiota disturbed by the antibiotic
Administering specific probiotic strains for antibiotic-associated diarrhea aims to restore the native gut microbiota that has been disrupted by antibiotic treatment. Antibiotics can non-selectively deplete beneficial intestinal bacteria, leading to dysbiosis and opportunist pathogen

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131. (D) High-fat, high-sodium cheeses are optimal for general geriatric daily nutrition
Consuming high fat and high sodium cheeses as a staple is highly discouraged in geriatric nutrition because older individuals face elevated cardiovascular and hypertension risks. Saturated fat and sodium restrictions are central to senior dietary plans. Formulating geriatric dairy requires optimizing protein and micronutrients like vitamin B_{12} while carefully limiting excess salt and fat.

132. (A) By compensating for reduced gastric acid and lower pancreatic enzyme secretion
Enhancing the digestibility of geriatric dairy foods directly compensates for age related reductions in gastric acid production and lower pancreatic enzyme secretion. By pre digesting or hydrolyzing proteins and lactose, the metabolic system can easily assimilate these vital nutrients without causing gastrointestinal distress, bloating, or malabsorption issues often encountered by elderly consumers.

133. (C) I, II, and IV
For optimal bone health in the elderly, calcium fortification is combined with vitamin D to enhance intestinal absorption. Vitamin K2 is added to guide calcium deposition specifically into bone tissue rather than arterial walls, and phytoestrogens can support bone mineral density in postmenopausal women, whereas dairy proteins should be maintained to support structural bone collagen matrices.

134. (A) The rheological properties and fluid viscosity
Modifying the rheological properties and fluid viscosity is the critical formulation strategy used to address dysphagia in clinical geriatric dairy foods. Thickened beverages and cohesive semi solids move slower through the mouth and pharynx, reducing the risk of accidental aspiration into the respiratory tract and ensuring safe, comfortable swallowing for compromised patients.

135. (D) Sodium
High sodium supplementation is strictly avoided in geriatric dairy formulations due to its direct association with fluid retention, arterial stiffening, and hypertension. Older populations generally require low sodium diets to manage blood pressure and protect cardiac health, whereas nutrients like calcium, vitamin D, and whey proteins are actively supplemented to prevent sarcopenia and osteoporosis.

136. (B) It has a higher concentration of leucine, a key trigger for muscle synthesis
Whey protein is particularly advantageous for geriatric muscle recovery because it contains high concentrations of leucine. Leucine behaves as a direct chemical trigger that activates the cellular mammalian target of rapamycin pathway, initiating muscle protein translation and synthesis. This amino acid profile helps overcome aging related anabolic resistance and preserves essential skeletal muscle mass.

137. (C) Treating the milk with exogenous beta-galactosidase enzymes
Treating fluid milk with exogenous beta galactosidase enzymes is the most effective commercial method to reduce the lactose load without affecting vital protein or calcium levels. This enzymatic process breaks down lactose into glucose and galactose, creating an easily digestible dairy beverage that prevents abdominal pain, gas, and bloating in lactose intolerant elderly consumers.

138. (D) Leucine, Isoleucine, Valine
The functional core of branched chain amino acids utilized in sports nutrition consists of leucine, isoleucine, and valine. These three essential amino acids share a unique aliphatic branched side chain structure and are unique because they are metabolized directly within skeletal muscle tissue rather than the liver, serving as immediate energy sources and muscle anabolic triggers.

139. (A) WPI is processed to contain ninety percent or more protein with minimal fat and lactose
Whey Protein Isolate is defined by its extensive processing to contain ninety percent or more protein on a dry weight basis, with almost all fats and lactose removed. This makes it highly distinct from Whey Protein Concentrate, which retains higher lipid and carbohydrate fractions, offering athletes a highly purified, fast absorbing protein source with minimal calories.

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140. (A) I and II
In sports nutrition, whey is categorized as a fast protein because it remains soluble in the stomach, leading to rapid gastric emptying and amino acid absorption. Conversely, casein is a slow protein that forms a gel in the stomach acid, providing

between milk amino acids and reducing sugars, forming complex pigment molecules called melanoidins that darken the residue.

215. (A) Both (A) and (R) are true and (R) is the correct explanation of (A).
Extracts of ghee residue are highly effective at extending the shelf life of other lipid products because they contain high concentrations of natural antioxidants. During thermal clarification, active phospholipids and sulfhydryl groups are liberated from milk proteins. These compounds chemically scavenge free radicals, delaying auto oxidation and preventing rancidity in food formulations.

216. (B) Direct intravenous injection as a clinical nutritional supplement
Ghee residue is a highly valued food byproduct but cannot be used for direct intravenous injection as a clinical nutritional supplement. Intravenous solutions must be completely sterile, fully soluble, and free of physical particles. Ghee residue is an insoluble, highly particulate thermal mixture of proteins and fats suited only for oral consumption or animal feed.

217. (C) The proteins are denatured, cross-linked, and coprecipitated with lactose and fat
Compared to raw milk, the protein fraction in ghee residue is fully denatured, extensively cross linked, and co precipitated with sugars and lipids. The severe thermal treatment applied during ghee processing fully deconstructs native casein micelles and whey proteins, causing them to physically aggregate and bind chemically with reducing sugars in a solid, insoluble state.

218. (D) A nutritional thermal byproduct with potential for upcycling
Ghee residue is best classified as a nutritional thermal byproduct with high potential for upcycling. It represents a valuable secondary stream generated from standard dairy fat clarification. Rich in caramelized milk solids, fat, and natural antioxidants, this matrix can be safely upcycled into diverse commercial applications, including bakery ingredients, traditional sweets, and energy dense animal feeds.

219. (A) The lactose- and mineral-rich stream passing through an ultrafiltration membrane
Whey permeate is defined as the lactose and mineral rich liquid stream that passes directly through an ultrafiltration membrane during protein concentration. This filtration process separates larger whey proteins, which are retained, from the smaller soluble components, yielding a clear, low protein byproduct that serves as an excellent cheap source of dairy carbohydrates.

220. (B) Lactose
The carbohydrate lactose constitutes the overwhelming majority, exceeding eighty percent, of the total dry matter weight in standard whey permeate. Because ultrafiltration membranes allow only molecules smaller than proteins to pass through, lactose and soluble minerals are concentrated in the permeate stream, making it a highly abundant, cost effective source of dairy sugars.

221. (B) It contains concentrated intact whey proteins, lipids, and minerals from the original whey
Sweet whey retentate is characterized as the liquid stream retained by the ultrafiltration membrane. This concentrated fraction contains intact native whey proteins like beta lactoglobulin, residual milk lipids, and colloidal minerals from the original whey. It is highly valued for drying into functional whey protein concentrates used widely across the food industry.

222. (A) It blends with cereals to act as a browning and flavor agent via Maillard reactions
Dairy permeate is technologically utilized in extrusion cooking of snack foods by blending with cereals to act as a potent browning and flavoring agent. The high concentration of lactose reacts with cereal proteins under high extrusion heat and pressure. This non enzymatic Maillard reaction generates attractive golden colors and desirable toasted dairy flavor notes.

223. (C) Permeate powder behaves identically to highly stable, pure sand during the drying process
Permeate powder is highly hygroscopic and sticky, behaving completely opposite to stable, free flowing sand during spray drying. The very high concentration of amorphous lactose and organic acids results in a low glass transition temperature. This cause the powder particles to adhere strongly to dryer walls and undergo severe physical caking, requiring careful pre crystallization.

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while maintaining the physical emulsion stability of fluid milk.

150. (A) Sucrose is heavily preferred as a bulking sweetener due to its high GI
Sucrose is highly avoided in diabetic friendly dairy products due to its high glycemic index, which causes unwanted blood glucose spikes. Instead, formulators utilize low glycemic sweeteners, resistant starches, and soluble dietary fibers to delay digestion and slow glucose absorption. Natural dairy protein and lactose already have a relatively low glycemic response compared to simple glucose.

151. (A) Both (A) and (R) are true and (R) is the correct explanation of (A).
Phytosterols incorporated into functional dairy matrices effectively lower serum low density lipoprotein cholesterol in hyperlipidemic individuals. This reduction occurs because phytosterols possess a chemical structure highly similar to cholesterol, allowing them to competitively displace cholesterol molecules from mixed micelles in the small intestine, thereby inhibiting its absorption and lowering systemic levels.

152. (B) It forms a viscous gel in the gut, trapping bile acids and blunting glucose spikes
The addition of beta glucan to dairy systems assists in managing metabolic disorders by forming a highly viscous gel matrix inside the intestinal tract. This physical gel slows down gastric emptying, traps bile acids to reduce liver cholesterol levels, and blunts postprandial glucose spikes by significantly delaying the enzymatic hydrolysis and absorption of dietary carbohydrates.

153. (A) I and II
In therapeutic dairy formulations, dietary fiber effectively decreases the energy density of the product, aiding weight management. Additionally, functional dairy peptides containing the specific valine proline proline sequence display strong angiotensin converting enzyme inhibitory activity, which helps lower arterial blood pressure and manage clinical hypertension, while high glycemic carbohydrates are avoided.

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154. (D) Erythritol
Erythritol is a sugar alcohol that serves as an excellent low glycemic sweetener for diabetic friendly dairy formulations. It possesses almost zero caloric value because it is absorbed in the small intestine but cannot be metabolized by the human body, being excreted completely unchanged, thus causing absolutely no rise in blood sugar or insulin levels.

155. (A) Severe renal failure requiring strict protein restriction
A high protein, low carbohydrate dairy formulation is highly contraindicated for individuals with severe renal failure. Compromised kidneys cannot efficiently filter and excrete the nitrogenous byproducts of extensive protein metabolism, leading to a dangerous buildup of urea in the blood. Such patients require strict dietary protein restriction to avoid accelerating kidney damage.

156. (B) MUFAs lower LDL cholesterol without reducing HDL, unlike saturated fats
Monounsaturated fatty acids like oleic acid are highly beneficial compared to saturated dairy fats because they lower low density lipoprotein cholesterol without reducing protective high density lipoprotein cholesterol. Saturated fats often elevate both fractions, raising overall cardiovascular risk. Replacing saturated milk fats with monounsaturated oils improves the lipid profile of functional dairy beverages.

157. (B) A significant reduction in systemic arterial blood pressure
Formulating a therapeutic yogurt with elevated levels of whey derived angiotensin converting enzyme inhibitory peptides directly results in a significant reduction of systemic arterial blood pressure. These biopeptides prevent the conversion of angiotensin I to the potent vasoconstrictor angiotensin II, promoting blood vessel dilation and helping to clinically manage hypertension safely.

158. (A) Maintaining a stable emulsion and preventing lipophilic sterol separation
The primary technological challenge when fully replacing milk fat with therapeutic plant sterols in liquid formulations is maintaining a stable emulsion and preventing lipophilic sterol separation. Plant sterols are highly hydrophobic and tend to recrystallize or separate, requiring

a sustained release of amino acids, which is ideal post workout and overnight.

141. (B) The post-exercise period when muscle cells show high sensitivity to amino acid uptake
The muscle recovery window describes the specific post exercise period during which skeletal muscle cells display heightened physiological sensitivity to amino acid uptake and protein synthesis. Consuming highly bioavailable whey based formulations during this critical time accelerates cellular myofibrillar repair, minimizes post exercise protein catabolism, and maximizes glycogen replenishment, leading to faster muscular adaptation.

142. (A) Dairy proteins cause severe muscle catabolism if consumed immediately after a workout
Consuming dairy proteins immediately after exercise actively promotes muscle anabolism and tissue repair rather than causing muscle catabolism. Whey and casein deliver highly bioavailable essential amino acids that rapidly halt muscle breakdown. Co ingesting carbohydrates with these dairy proteins further optimizes recovery kinetics by elevating insulin levels and accelerating glycogen resynthesis in depleted muscle tissues.

143. (C) It activates the mTOR signaling pathway, initiating muscle protein translation
The branched chain amino acid leucine stimulates muscle hypertrophy by activating the intracellular mechanistic target of rapamycin signaling pathway. This key biochemical pathway regulates cell growth and protein translation, converting amino acids into physical muscle fibers post exercise. Leucine serves as a direct molecular switch that initiates muscle protein synthesis following high intensity workouts.

144. (D) P-4, Q-3, R-1, S-2
In sports nutrition formulations, micellar casein is utilized for sustained nocturnal amino acid delivery, while whey protein hydrolysate provides ultra fast delivery of pre digested peptides. Added maltodextrin acts to rapidly replenish glycogen stores, and electrolytes restore structural fluid balance. This strategic combination of ingredients supports comprehensive muscle recovery, hydration, and long term recovery.

145. (C) Serving as a major source of dietary fiber to promote colon motility
Whey protein concentrates provide essential amino acids, bioactive immunoglobulins for immune support, and excellent solubility, but they contain absolutely no dietary fiber. Fiber is an indigestible carbohydrate derived from plant sources, whereas whey is a dairy fluid derivative. Formulators must add separate plant fibers if colon motility benefits are desired in sports drinks.

146. (B) They bypass digestive steps as they are pre-cleaved, enabling faster absorption
Whey protein hydrolysates are superior for elite recovery because they bypass several gastrointestinal digestive steps. Since the proteins are enzymatically pre cleaved into smaller di and tri peptides, they are absorbed significantly faster in the small intestine than intact proteins. This rapid absorption triggers a faster rise in blood amino acids, accelerating muscle repair.

147. (D) A night-time or prolonged recovery sustained-release matrix
A sports drink formulated with eighty percent casein and twenty percent whey provides a sustained release of amino acids, making it a classic night time or prolonged recovery matrix. Casein slowly coagulates in the stomach to prevent muscle protein breakdown for several hours, while the whey fraction delivers immediate amino acids for initial repair.

148. (A) A measure of how fast a food raises blood glucose compared to a reference food
The Glycemic Index is formally defined as a relative numerical measure indicating how rapidly carbohydrates in a specific food are digested and absorbed, subsequently raising blood glucose levels compared to an equivalent reference food like pure glucose or white bread. This scale helps in designing therapeutic diets to manage metabolic and diabetic conditions.

149. (C) Replacing dairy fat with plant sterols or functional omega-3 fatty acids
Designing cardiovascular protective dairy products requires replacing highly saturated milk fats with functional plant sterols or omega three fatty acids. These plant lipids actively lower circulating low density lipoprotein cholesterol by inhibiting cholesterol absorption in the gut. This formulation reduces cardiovascular plaque risks

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them to lose their microparticulated spherical shape, leading to protein aggregation and gelation, which completely destroys the smooth, lubricating texture required to mimic real dairy fat.

169. (C) Potassium chloride
Potassium chloride is the most widely utilized compound for replacing sodium chloride in low sodium dairy formulations. Because potassium possesses a similar ionic size and charge to sodium, it can partially replicate the salty taste and essential ionic functionality required for protein hydration and water binding, though its usage levels must be carefully controlled.

170. (D) Using specific flavor modulators to hide the metallic off-notes of potassium chloride
Bitterness masking in low sodium cheese processing is defined as the utilization of specific flavor modulators or blocker compounds to suppress the metallic, bitter off notes of potassium chloride. This sensory technique allows cheese manufacturers to replace sodium chloride more aggressively without compromising the consumer acceptance and characteristic flavor profile of the cheese.

171. (A) It completely halts all enzymatic ripening and flavor development permanently
Sodium chloride regulates but does not completely halt enzymatic ripening and flavor development in cheese. It functions to control microbial growth, manage moisture, adjust water activity, and optimize curd texture. Complete inhibition of ripening enzymes would prevent the generation of characteristic aging flavors, making salt reduction a delicate balancing act for cheese manufacturers.

172. (B) KCl imparts an objectionable bitter and metallic off-flavor at high levels
A direct one to one replacement of sodium chloride with potassium chloride is limited because potassium ions stimulate both salty and bitter taste receptors. At high replacement levels, potassium chloride imparts a highly objectionable bitter and metallic off flavor, necessitating the use of specialized flavor masking agents or stepwise, partial reduction strategies.

173. (B) Cause: Lower osmotic pressure. Effect: Complete inhibition of all lactic acid bacteria, resulting in zero acid development
Reducing salt in Cheddar cheese actually lowers osmotic pressure, which stimulates rather than inhibits the growth of starter and non starter lactic acid bacteria, potentially leading to rapid and uncontrolled acid development. Salt is traditionally added to slow down acid production and control bacterial cell viability, ensuring proper curd structure during ripening.

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174. (A) I, II, and IV
Successful low sodium dairy strategies include the stepwise, gradual reduction of salt over time to allow consumer palate adaptation, and the use of yeast extracts or umami compounds to enhance salty perception. Modifying the physical crystal structure of salt also increases its dissolution rate, while replacing salt with sucrose is chemically inappropriate.

175. (A) P-3, Q-2, R-1, S-4
Low sodium strategies are mapped to specific mechanisms: potassium chloride offers direct ionic substitution of sodium, yeast extracts provide cross modal sensory enhancement through umami synergy, hollow salt crystals increase spatial flavor perception with less mass, and stepwise reduction relies on the gradual neuro sensory adaptation of the consumer to lower salt levels.

176. (D) Acting as a potent fat replacer to lower total calories
Salt performs vital functions in butter manufacturing, including acting as a primary preservative, enhancing flavor, and suppressing spoilage microbes, but it cannot act as a fat replacer or lower calorie density. Butter is composed primarily of lipids, and salt is dissolved in the small aqueous phase to control moisture distribution and stability.

177. (C) The para-casein network becomes over-hydrated and weak, destroying the body
Complete removal of sodium without ionic replacement causes the para casein network of the cheese curd to become over hydrated and physically weak. Without sodium ions to regulate protein charge and hydration, the protein matrix binds excess water, leading to a weak, pasty, and structurally undesirable cheese body that undergoes rapid microbial decay.

high pressure homogenization and food emulsifiers to ensure uniform physical dispersion throughout shelf life.

159. (C) An ingredient that mimics fat properties but contributes fewer calories
In reduced calorie dairy technology, a fat replacer is defined as any ingredient engineered to mimic the physical, rheological, and sensory properties of natural fats while contributing significantly fewer dietary calories. These substances can be protein, carbohydrate, or lipid based, helping to maintain desirable creaminess and mouthfeel in low fat formulations.

160. (D) Simplesse
Simplesse is a highly successful commercial fat replacer derived from microparticulated whey protein. Through a physical shearing and heating process, the whey proteins are shaped into microscopic spheroids that roll over the tongue, mimicking the exact mouthfeel and lubricating creaminess of fat globules without contributing high lipid calories to dairy products.

161. (C) It is absorbed into the blood but cannot be metabolized, being excreted unchanged
Erythritol is a near zero calorie sweetener because it is rapidly absorbed into the bloodstream from the small intestine but cannot be biochemically metabolized by human enzymes. Consequently, more than ninety percent of the ingested erythritol is excreted completely unchanged in the urine, providing sweetness without adding any significant metabolic energy.

162. (B) The proteins are micro-particulated into spheres that mimic fat droplets on the tongue
Microparticulated whey protein successfully simulates the mouthfeel of dairy fat in low calorie formulations because the proteins are physically shaped into tiny micro spheres. These spheroids, measuring between zero point five and two microns, roll smoothly across sensory taste receptors, mimicking the physical friction and tactile lubrication typically provided by lipid droplets.

163. (D) Aspartame is highly stable under severe thermal processes like UHT and baking
Aspartame is highly unstable under high thermal processes such as ultra high temperature pasteurization and baking, because high heat causes it to hydrolyze into its constituent amino acids, losing all of its sweetness. For heat treated dairy products, alternative intensive sweeteners like sucralose or steviol glycosides are preferred due to their superior thermal stability.

164. (C) $I \rightarrow II \rightarrow III \rightarrow IV$
Sweeteners are arranged from lowest to highest sweetness potency starting with lactose, which is less sweet than sucrose. Sucrose acts as the standard reference. Aspartame is an intensive sweetener about two hundred times sweeter than sucrose, while neotame represents the highest tier, possessing a sweetness potency thousands of times greater than sucrose.

165. (C) To replace physical mass, volume, and texture lost when high-volume sugars are removed
Bulking agents are absolutely necessary when reformulating dairy products with intense artificial sweeteners because these sweeteners are used in minuscule amounts. Removing bulk sugars like sucrose causes a severe loss of physical mass, solids content, viscosity, and volume. Ingredients like polydextrose or maltodextrin must replace this physical volume to maintain acceptable texture.

166. (A) P-2, Q-1, R-3, S-4
Reduced calorie ingredients are classified by chemical type: maltodextrin acts as a carbohydrate fat replacer and bulking agent, while Simplesse is a microparticulated protein fat replacer. Sucralose represents a synthetic high intensity sweetener, and polydextrose functions as a highly branched synthetic bulking polymer. Together, these ingredients restore physical texture in low fat dairy.

167. (D) Mineral oil
Mineral oil cannot be utilized as a carbohydrate based fat replacer in food or dairy products because it is a non edible hydrocarbon petroleum derivative that is completely indigestible and poses safety concerns. Conversely, starches, celluloses, and pectins are edible plant carbohydrates widely used to safely mimic fat viscosity and water binding properties.

168. (B) They denature and gel at high temperatures, losing their smooth fat-mimicking texture
Protein based fat replacers like Simplesse are limited in high temperature applications like baking or processed cheese because thermal processing denatures the proteins. This causes

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187. (A) Fungal lactases have a lower optimal pH, making them ideal for acidic whey or yogurts
Fungal lactases derived from Aspergillus species have a lower optimal pH range, making them highly suited for acidic dairy products like yogurt and acid whey. Yeast lactases, conversely, function best under neutral pH conditions typical of fresh fluid milk. This pH versatility allows fungal enzymes to hydrolyze lactose efficiently in fermented products.

188. (B) Ultra-filtered, zero-carbohydrate dairy beverage
A dairy beverage where lactose has been mechanically filtered out and replaced with a non caloric sweetener is classified as an ultra filtered, zero carbohydrate dairy beverage. This advanced processing utilizes filtration membranes to isolate and remove natural dairy sugars while retaining milk proteins and calcium, creating a diabetic friendly, functional milk alternative.

189. (B) Ionized mineral migration through ion-selective membranes driven by electrical current
The operating principle of electrodialysis in whey demineralization involves the migration of ionized minerals through ion selective membranes driven by an electrical current. Cations move toward the cathode and anions toward the anode, passing through selective membranes that block proteins and lactose, thereby efficiently separating inorganic salts from the organic dairy solids.

190. (A) IE passes whey through polymer beads exchanging mobile counter-ions for mineral ions
Ion exchange demineralization works by passing liquid whey through polymer resin beds where mobile counter ions are exchanged for mineral ions present in the whey. Cation resins exchange hydrogen ions for mineral cations like calcium and sodium, while anion resins exchange hydroxyl ions for mineral anions, yielding highly purified, low ash whey solids.

191. (C) 150 to 1000 Daltons, retaining organic lactose while passing monovalent ions and water
Nanofiltration membranes in the dairy industry utilize a molecular weight cut off range of one hundred fifty to one thousand Daltons. This unique pore size allows the membrane to effectively retain larger organic disaccharides like lactose and proteins while allowing water and small monovalent mineral ions like sodium and chloride to pass through, achieving simultaneous concentration and partial demineralization.

192. (D) It lowers the mineral ash content of whey, preventing osmotic overload in infant kidneys
Demineralizing whey is critical for infant formula production because it lowers the overall mineral ash content. Raw whey has a very high mineral concentration that would cause dangerous osmotic overload in immature infant kidneys. Removing these minerals allows manufacturers to match the precise, safe mineral profile of human breast milk in the final product.

193. (C) ED is vastly superior for removing non-ionic compounds compared to IE
Both electrodialysis and ion exchange rely strictly on electrical charges and ionic affinity, making them fundamentally ineffective at removing non ionic neutral compounds like lactose. Electrodialysis drives charged ions through selective membranes, while ion exchange binds charged species to resins. Neither technology is superior for non ionic separations, which require size exclusion membrane processes.

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194. (B) The precipitation of calcium phosphate and protein deposition on the membrane pores
Severe membrane fouling during the nanofiltration of raw acid whey is directly caused by the precipitation of calcium phosphate and protein deposition on membrane pores. The high mineral acidity of acid whey keeps calcium solubilized, but concentration increases saturation, causing calcium phosphate to precipitate and block the polymer membrane pores, reducing flux rates.

195. (B) $III \rightarrow I \rightarrow II \rightarrow IV$
Demineralizing highly salty cheese whey requires a specific operational order. First, raw whey undergoes clarification and fat separation. Next, nanofiltration is applied for concentration and partial monovalent ion removal. Then, electrodialysis or ion exchange is utilized for deep, comprehensive demineralization. Finally, spray drying converts the purified mineral depleted concentrate into a stable powder.

196. (A) HTST pasteurization
High temperature short time pasteurization is designed solely to eliminate pathogenic bacteria and extend shelf life through thermal inactivation, having absolutely no effect on mineral content. Effective demineralization

requires ion separation technologies such as electrodialysis, nanofiltration, or ion exchange, which physically isolate and remove inorganic minerals from the fluid whey matrix.

197. (C) Ion exchange generates large volumes of acidic and basic wastewater during resin regeneration
The primary environmental disadvantage of ion exchange demineralization compared to electrodialysis is the generation of large volumes of highly acidic and basic chemical wastewater during resin bed regeneration. This process requires strong hydrochloric acid and sodium hydroxide to restore resin capacity, creating chemical disposal challenges, whereas electrodialysis operates continuously using electrical forces.

198. (A) A pressure-driven membrane process between reverse osmosis and ultrafiltration
Nanofiltration is classified as a pressure driven membrane separation process positioned between reverse osmosis and ultrafiltration. It operates under moderate hydrostatic pressures to separate low molecular weight solutes. The membrane allows single charged monovalent ions to pass while retaining multivalent ions and organic disaccharides like lactose, making it ideal for concentration.

199. (D) The aqueous byproduct from churning fresh, unfermented sweet cream into butter
Sweet buttermilk is defined as the aqueous byproduct generated during the physical churning of fresh, unfermented sweet cream into butter. It is highly similar in basic macronutrients to skim milk, containing water, proteins, and lactose, but features a high concentration of polar lipids and membrane fragments released from disrupted fat globules.

200. (A) I, II, and IV
Sweet buttermilk possesses a significantly higher concentration of Milk Fat Globule Membrane components compared to whole milk. It is exceptionally rich in polar lipids like functional phospholipids, and its total protein content is equivalent to skim milk. It does, however, contain standard levels of lactose, making sweet buttermilk a highly nutritious dairy stream.

201. (C) The churning of cream fermented by lactic acid-producing starter cultures
Sour buttermilk is biochemically characterized by its origin from churning cream that has been deliberately fermented by lactic acid producing starter cultures. This fermentation process lowers the pH, causes partial protein aggregation, and generates characteristic flavor compounds like diacetyl, giving sour buttermilk its unique acidic taste and highly refreshing sensory properties.

202. (D) Its MFGM phospholipids act as natural emulsifiers, improving overrun and texture
Sweet buttermilk enhances ice cream formulations because its Milk Fat Globule Membrane phospholipids function as highly effective natural emulsifiers. These polar lipids promote stable fat crystallization, improve air cell incorporation during freezing, and increase structural overrun. This leads to a smoother physical texture, better melt resistance, and an enhanced creamy mouthfeel.

203. (A) Buttermilk powder possesses an indefinite shelf-life at high temperatures without any packaging protection
Buttermilk powder does not possess an indefinite shelf life and is highly vulnerable to rapid lipid oxidation when exposed to high temperatures and air. The powder features elevated levels of polar phospholipids and unsaturated fatty acids from disrupted fat membranes, requiring careful protective packaging and cool storage temperatures to prevent off flavor development.

204. (B) Volatile fatty acids, sulfhydryl compounds, and phospholipids generated during processing
The distinct, rich, and nutty flavor profile of sweet buttermilk powder is caused by volatile fatty acids, sulfhydryl compounds, and active phospholipids liberated during thermal pasteurization and concentration. Heat treatment releases volatile sulfur compounds from dairy proteins, which interact synergistically with milk lipids to create highly desirable cooked butter flavor notes.

205. (B) $II \rightarrow III \rightarrow IV \rightarrow I$
The industrial production of sweet buttermilk powder requires a strict processing sequence. First, sweet cream is churned to drain the liquid buttermilk phase. Next, this raw buttermilk undergoes pasteurization to ensure microbiological safety. The pasteurized stream is

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then evaporated to concentrate dairy solids, and finally, spray drying converts the concentrate into a stable powder.

206. (A) P-4, Q-3, R-2, S-1
Buttermilk components are linked to functional applications: sphingomyelin supports cellular signaling, and phosphatidylserine enhances clinical cognitive function. Native proteins serve as excellent structural emulsifiers in bakery systems, and the lactic acid in sour buttermilk acts as an effective mild antimicrobial and flavoring agent, optimizing final product shelf life and safety.

207. (C) Direct processing into hard, aged Cheddar cheese as the sole ingredient
Sweet buttermilk powder is highly unsuitable for processing into hard, aged Cheddar cheese as the sole ingredient. Cheddar manufacturing requires structured casein micelle clotting, whereas buttermilk has highly disrupted fat globule membranes, concentrated phospholipids, and denatured protein fractions. This unique composition prevents proper curd formation and yields a physically compromised cheese structure.

208. (D) Sour buttermilk acidity reduces protein heat stability, causing dryer clogging and corrosion
Sweet buttermilk is preferred for large scale spray drying because the high acidity of sour buttermilk reduces protein heat stability. Acidic environments cause caseins to aggregate and precipitate during heating, leading to severe nozzle clogging, wall sticking in the drying chamber, and accelerated physical corrosion of processing equipment, reducing manufacturing efficiency.

209. (C) The brownish solid containing protein, lactose, and fat, recovered during ghee clarification
Ghee residue is defined as the brownish solid byproduct containing milk proteins, caramelized lactose, and entrapped fat recovered during the final clarification step of ghee production. This thermal residue settles at the bottom of the heating vessel, undergoing extensive Maillard browning and caramelization, yielding a rich, highly concentrated, flavor active secondary dairy matrix.

210. (B) Entrapped milk fat
In unpressed standard ghee residue, entrapped milk fat constitutes the highest percentage of the total dry matter weight. This occurs because the protein and carbohydrate solids form a highly porous, physical matrix that physically traps large amounts of liquid butterfat during the high heat separation phase, necessitating mechanical pressing or centrifugation to yield defatted solids.

211. (A) I and II
Ghee residue exhibits exceptionally potent natural antioxidant properties and contains high concentrations of Maillard reaction products like melanoidins. These compounds are synthesized during high temperature clarification, where proteins and reducing sugars react. The resulting antioxidants significantly enhance the oxidative stability of fat based food systems, acting as highly effective natural shelf life extenders.

212. (A) By utilizing its caramelized, cooked-butter flavor compounds to enrich bakery products
Ghee residue is technologically utilized to enhance bakery formulations by delivering highly intense, caramelized, cooked butter flavor notes. The complex Maillard compounds and roasted milk proteins present in the residue provide premium sensory characteristics to cookies, cakes, and pastries, allowing manufacturers to naturally enhance product flavor while recycling a valuable nutritional dairy byproduct.

213. (C) The extreme heat of ghee making ensures the residue contains highly intact, un-denatured whey proteins
The extreme thermal processing during ghee manufacturing, which typically exceeds one hundred ten degrees Celsius, fully denatures and cross links all whey proteins. Un denatured proteins cannot survive these conditions. The residue is actually a highly consolidated, thermally coagulated matrix of denatured milk solids, degraded lactose, and co precipitated lipids that settle during clarification.

214. (A) Maillard browning and lactose caramelization at temperatures over 110 degrees
The definitive dark brown coloration of standard ghee residue is directly caused by intense Maillard browning and lactose caramelization occurring at processing temperatures exceeding one hundred ten degrees Celsius. This thermal environment accelerates chemical reactions

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178. (B) Removing sodium incrementally across production cycles without informing consumers on labels
A stealth reduction strategy describes the method of incrementally and slowly reducing sodium levels in commercial dairy products over several production cycles without highlighting the change on front packaging. This allows the consumer's neuro sensory receptors to gradually adapt to lower salt concentrations, maintaining high product acceptability without triggering negative taste biases.

179. (D) Gastrointestinal distress caused by deficiency of the intestinal enzyme lactase
Lactose intolerance is clinically defined as gastrointestinal distress resulting directly from a deficiency of the brush border enzyme lactase in the small intestine. Unable to hydrolyze the disaccharide lactose into glucose and galactose, the undigested sugar passes into the colon, where bacterial fermentation produces organic acids and gases, causing abdominal cramps, flatulence, and diarrhea.

180. (A) II and III
In low lactose milk production, the lactase enzyme hydrolyzes lactose into glucose and galactose, and this enzyme is typically sourced from yeasts like Kluyveromyces lactis or fungi like Aspergillus oryzae. This enzymatic breakdown increases the perceived sweetness of the milk, since glucose and galactose have higher relative sweetness potencies than the original lactose molecule.

181. (C) The hydrolysis creates glucose and galactose, which are highly reactive reducing sugars
The intensified Maillard browning in lactose hydrolyzed UHT milk during storage is directly caused by the creation of glucose and galactose. These monosaccharides are highly reactive reducing sugars compared to the original disaccharide lactose, reacting rapidly with the free epsilon amino groups of milk proteins, particularly lysine, under typical storage temperatures.

182. (A) Sterile enzyme is injected into the milk after UHT treatment and before packaging
The aseptic or post pasteurization method involves injecting a sterile lactase enzyme preparation directly into the milk stream after UHT sterilization but immediately before packaging. This process prevents thermal denaturation of the enzyme, allowing lactose hydrolysis to occur progressively inside the sealed carton during storage and transport, saving energy and processing time.

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183. (D) It causes the milk to instantly curdle and form a hard cheese-like matrix
Enzymatic hydrolysis of lactose into glucose and galactose does not cause milk to curdle or form a cheese matrix. Curdling requires proteolytic cleavage of casein or acid denaturation of proteins, neither of which is caused by lactase. Hydrolysis increases sweetness, lowers the freezing point, and improves the fermentability of the milk by starter cultures.

184. (B) By ultra-filtering out lactose before drying instead of only hydrolyzing it
To mitigate excessive Maillard browning in lactose free milk powder, manufacturers can utilize membrane ultrafiltration to physically remove the lactose from the liquid milk before drying. This step significantly reduces the total concentration of highly reactive reducing sugars available to react with milk proteins, ensuring high optical brightness and preventing nutrient degradation during storage.

185. (C) P-4, Q-1, R-2, S-3
Lactose reduction technologies rely on distinct principles: chromatographic separation fractionates molecules based on affinity, while enzymatic hydrolysis cleaves the beta one four glycosidic bond. Ultrafiltration utilizes physical size exclusion through semi permeable membranes to remove lactose, and fermentation relies on starter cultures to biochemically convert the lactose disaccharide into lactic acid.

186. (D) A strong, pungent metallic bitterness resembling potassium chloride
Lactose hydrolyzed milk exhibits a distinctly sweeter taste, a slightly thinner perceived viscosity, and a darker color over time, but it does not develop a metallic bitterness resembling potassium chloride. Any slight off flavors in hydrolyzed milk are typically sweet or caramelized due to reactive monosaccharides rather than metallic mineral sensations.

224. (D) The low glass transition temperature of lactose and organic acids, making the matrix rubbery
The primary cause of physical stickiness during the spray drying of high lactose dairy permeates is the low glass transition temperature of lactose and organic acids. At typical dryer temperatures, these components remain in a highly sticky, rubbery amorphous state rather than a stable glass, causing particles to adhere to chamber walls and aggregate.

225. (C) P-3, Q-2, R-4, S-1
Dairy byproduct streams are matched with specific applications: whey permeate serves as a cheap carbohydrate bulking agent, liquid whey retentate is the precursor for drying concentrated whey protein, delactosed permeate is utilized as a mineral source for animal feed block formulations, and acid whey permeate serves as a fermentation substrate due to challenging drying properties.

226. (B) Drastically increasing the relative humidity of the inlet drying air to 100%
Increasing the relative humidity of the inlet drying air to one hundred percent is completely ineffective and worsens stickiness during permeate drying. High humidity lowers the glass transition temperature of lactose, driving it into a highly rubbery state that sticks to equipment. Effective solutions instead include lactose pre crystallization and blending with stable carbohydrate carriers.

227. (D) Its high lactose serves as a cheap carbon source for bioethanol or single-cell proteins
Whey permeate is extensively utilized as an industrial fermentation substrate because its extremely high lactose concentration serves as a cheap, abundant carbon source. Microorganisms can metabolize this dairy sugar to produce valuable bioethanol, organic acids, or single cell proteins, providing a highly economical upcycling route for a byproduct that is otherwise difficult and costly to dry.

228. (A) The glass transition temperature in relation to storage temperature and humidity
The primary physical property that must be managed to successfully formulate stable permeate powders is the glass transition temperature in relation to storage temperature and humidity. Exposure to temperatures or humidity levels above this transition threshold drives amorphous lactose into a sticky, rubbery state, causing rapid moisture absorption, severe powder caking, and structural collapse.

229. (D) A is false but R is true.
Blending dairy retentate powders with extruded cereal matrices significantly decreases rather than increases physical product expansion because high levels of intact whey proteins strictly inhibit the rapid flashing off of steam at the die. The protein molecules form a rigid, highly structured matrix that limits the extensibility of starch walls, reducing final product volume.

230. (A) Freeze drying (Lyophilization)
Freeze drying or lyophilization is utilized as a specialized alternative drying technology for extremely sticky, heat sensitive dairy byproducts like acid whey permeate. This process sublimates ice directly into vapor under vacuum at sub zero temperatures, completely avoiding high heat and preventing the sticky amorphous state changes of lactose, despite having high capital costs.

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II. Sour - Blockage of potassium channels by hydrogen ions
III. Sweet - Activation of G-protein coupled receptors
IV. Bitter - Exclusively utilizes ion channel blockade

Which of the above statements is/are correct?
(A) I, II and IV
(B) I, II and III
(C) II, III and IV
(D) I and III

2017

75. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).

Assertion (A): The perception of astringency develops immediately upon tasting and dissipates rapidly once the sample is expectorated.

Reason (R): Astringency is a tactile sensation caused by the precipitation of salivary proteins, which takes time to develop and clear from the oral cavity.

(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2007

76. In psychophysics, which law is considered highly accurate for describing sensory magnitude across a wide range of stimulus intensities by utilizing an exponent unique to each sensory modality?
(A) Weber's Law
(B) Fechner's Law
(C) Stevens' Power Law
(D) Newton's Law of Cooling

2012

77. The terminal threshold is critically important in sensory evaluation because it indicates:
(A) The maximum physical point where a panelist refuses to consume more test samples
(B) The minimum concentration of a stimulus required for simple sensory detection
(C) The definitive statistical cutoff used for outlier data removal in QDA studies
(D) The saturation point beyond which increased intensity is unperceived

2025

78. Hardness in texture profile analysis is precisely defined as:
(A) The work required to chew the food to a state ready for swallowing
(B) The ratio of active deformation to total deformation
(C) The peak force generated during the first compression cycle
(D) The rate at which a deformed material returns to its original shape

2012

79. When designing a sensory testing laboratory, the preparation area should be physically separated from the evaluation booths to prevent:
(A) Panelists from observing the lighting conditions
(B) Noise and odor interference
(C) Cross-contamination of bacterial cultures
(D) The halo effect during scaling

2010

80. Match the sensory bias (List I) with its definition (List II).

List I: (Sensory bias)
P. Expectation error
Q. Habituation
R. Central tendency error
S. Synergy

List II: (Definition)
1. Panelists avoid using the extreme ends of a rating scale.
2. Two components blend to produce a sensation stronger than their sum.
3. Information about the product influences the panelist's perception before tasting.
4. Repeating the same sample leads to diminished analytical attention.

(A) P-4, Q-1, R-2, S-3
(B) P-3, Q-4, R-1, S-2
(C) P-3, Q-1, R-4, S-2
(D) P-1, Q-4, R-3, S-2

2024

81. In a Two-out-of-five test, panelists are presented with five samples. How many samples match the first reference type, and what is the guessing probability?
(A) Two match type A, three match type B; probability is 10%
(B) Three match type A, two match type B; probability is 10%
(C) Two match type A, three match type B; probability is 20%

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2004
10. Which psychological bias occurs when a panelist's evaluation of one attribute influences their perception of other distinct attributes in the same sample?
(A) Expectation error
(B) Halo effect
(C) Habituation
(D) Cross-adaptation

2013
11. Which discriminative sensory test involves presenting one reference sample followed by two coded samples, asking the panelist to identify which coded sample matches the reference?
(A) Duo-trio test
(B) Triangle test
(C) Paired-comparison test
(D) Two-out-of-five test

2011
12. Match the sensory testing scales (List I) with their defining characteristics (List II).
List I: (Sensory testing scales)
P. 9-point Hedonic scale
Q. Line scale
R. Unstructured scale
S. Structured scoring
List II: (Defining characteristics)
1. Uses discrete numerical or descriptive intervals
2. Measures degree of liking from dislike extremely to like extremely
3. A continuous line anchored at both ends without intermediate marks
4. Panelists mark a point on a line corresponding to perceived intensity
(A) P-1, Q-4, R-2, S-3
(B) P-2, Q-4, R-3, S-1
(C) P-2, Q-1, R-4, S-3
(D) P-3, Q-2, R-1, S-4

2014
13. Which descriptive sensory method relies heavily on the consensus of a highly trained panel to develop a universal language for product attributes?
(A) Hedonic testing
(B) Quantitative Descriptive Analysis (QDA)
(C) Paired-comparison test
(D) Flavour Profile Method

2023
14. In temporal sensory techniques, what does the Temporal Dominance of Sensations (TDS) method primarily measure over time?
(A) The continuous absolute intensity of all perceived attributes
(B) The overall temporal duration required to reach the terminal threshold limit
(C) The sensory attribute perceived as dominant at any given moment
(D) The progressive physical breakdown of product texture during mastication

2001
15. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): The Electronic Nose (E-nose) requires comprehensive prior training with known chemical standards to accurately classify complex dairy aromas.
Reason (R): E-nose systems utilize non-specific cross-reactive sensor arrays coupled with pattern recognition algorithms rather than analyzing individual compounds.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2025
16. Which specific off-flavor in liquid milk is primarily caused by the exposure of milk to ultraviolet or fluorescent light, leading to the degradation of riboflavin and methionine?
(A) Lipolyzed
(B) Malty
(C) Oxidized
(D) Light-activated

2018
17. In the sensory evaluation of butter, which textural defect is characterized by visible droplets of moisture exuding from the product surface?
(A) Leakiness
(B) Crumbly
(C) Sticky
(D) Mottling

2007
18. Consider the following statements regarding Cheddar cheese sensory defects:
I. A bitter flavor usually results from incomplete proteolysis accumulating hydrophobic peptides.
II. Late gas blowing leads to highly desirable uniform eye-formation.

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III. A corky texture is associated with excessively low moisture content.

Which of the above statements is/are correct?
(A) I and III
(B) II
(C) I and II
(D) III

2017

19. Sandiness in ice cream is a severe textural defect primarily caused by the crystallization of which milk component?
(A) Lactose
(B) Milk fat
(C) Sucrose
(D) Casein micelles

2021

20. During the sensory evaluation of Khoa, an undesirable excessive browning is generally attributed to which chemical process?
(A) Lipid oxidation
(B) Enzymatic proteolysis
(C) Lactose fermentation
(D) Maillard reaction

2025

21. Which textural attribute is considered highly desirable when evaluating high-quality Paneer?
(A) Hard and crumbly
(B) Soft and cohesive
(C) Spongy and elastic
(D) Grainy and loose

2013

22. In fermented milks such as Yoghurt, the physical defect of syneresis is sensorially perceived as what?
(A) An excessively sour and highly acidic taste profile
(B) A yeasty, effervescent, and gassy off-flavor development
(C) The separation of whey from the curd matrix
(D) A gritty, coarse, and distinctly sandy mouthfeel

2011

23. Which sensory defect in milk powder is directly related to the storage of the product in high humidity environments?
(A) Caramelized flavor
(B) Stale flavor
(C) Oxidized flavor
(D) Caking

2007

24. Consider the following statements regarding psychophysical theories:
I. Fechner's Law assumes that all Just Noticeable Differences are subjectively equal.
II. Stevens' Power Law models the relationship using a logarithmic function.
III. Weber's Law states that the ratio of the increment threshold to the background intensity is a constant.
IV. Fechner's Law is widely considered more accurate than Stevens' Power Law for extreme intensities.

Which of the above statements is/are correct?
(A) I and III
(B) II, III and IV
(C) I, II and IV
(D) II and IV

NODIA

2024

25. The phenomenon where continuous exposure to a specific stimulus decreases the olfactory sensitivity to that exact stimulus is termed:
(A) Synergy
(B) Adaptation
(C) Cross-adaptation
(D) Stimulus error

2005

26. Which structural component of the olfactory system is responsible for trapping odorants and dissolving them for receptor interaction?
(A) Olfactory bulb structure
(B) Olfactory mucosa
(C) Nasal conchae bones
(D) Cribriform plate barrier

2009

27. Chemesthesis differs from classical gustation primarily because it relies on the activation of which specialized pathways?
(A) Somatosensory and pain receptors
(B) Specialized taste receptor cells type II
(C) Secondary olfactory sensory neurons
(D) Posterior circumvallate papillae structures

2024

28. According to Stevens' Power Law, the relationship between subjective sensation magnitude and objective stimulus intensity is expressed mathematically as:
(A) $S = k \log I$
(B) $\frac{\Delta I}{I} = k$

(C) $S = kI^n$

(D) $S = \frac{k}{I}$

2014

29. The highest concentration of a stimulus beyond which no further increase in sensation intensity can be perceived is known as the:
(A) Recognition threshold
(B) Absolute threshold
(C) Difference threshold
(D) Terminal threshold

2015

30. Consider the following statements concerning sensory lab requirements:
I. ISO guidelines recommend a minimum relative humidity of 80% in testing booths.
II. Air handling systems should provide positive pressure in the preparation area to keep odors out of the booths.
III. Work surfaces should be easily cleanable, non-absorbent, and odor-free.
IV. Lighting should be uniform, glare-free, and capable of color masking.
V. The testing area must have direct, unimpeded airflow from the sample preparation kitchen.
Which of the above statements is/are INCORRECT?
(A) I, II and V
(B) II, III, IV and V
(C) I, III and IV
(D) III, IV and V

2023

31. Chewiness, a secondary parameter in texture profile analysis, is mathematically defined as the product of which primary parameters?
(A) Hardness, elasticity, and absolute viscosity
(B) Hardness, cohesiveness, and springiness
(C) Viscosity, adhesiveness, and gumminess indices
(D) Cohesiveness, adhesiveness, and surface friction

2019

32. Which bias is most likely occurring if a sensory panelist scores a dairy product higher simply because it is presented in premium, expensive-looking packaging?
(A) Expectation error
(B) Central tendency error
(C) Contrast effect
(D) Stimulus error

2022

33. In an untrained consumer panel, what is the primary objective of the sensory evaluation?
(A) To determine product acceptability and preference
(B) To identify trace off-flavors in raw milk
(C) To profile the specific texture degradation over a shelf-life period
(D) To calibrate the readings of an Electronic Nose

2012

34. What is the statistical probability of a panelist correctly guessing the odd sample in a standard Triangle test?
(A) 50.0%
(B) 33.3%
(C) 16.6%
(D) 25.0%

2003

35. Arrange the correct sequence of steps involved in conducting a Quantitative Descriptive Analysis (QDA).
(A) Term generation, Panel training, Product evaluation, Statistical analysis
(B) Panel training, Term generation, Product evaluation, Statistical analysis
(C) Term generation, Product evaluation, Panel training, Statistical analysis
(D) Product evaluation, Term generation, Panel training, Statistical analysis

2024

36. Which scoring method requires the panelist to rank a set of samples sequentially according to the perceived intensity of a specific attribute?
(A) Hedonic scaling
(B) Rating test
(C) Paired-comparison test
(D) Ranking test

2009

37. The Time-Intensity (TI) profiling technique is uniquely advantageous for evaluating which specific sensory phenomenon in dairy products?
(A) The overall acceptance and market preference of a new yoghurt flavor
(B) The temporal onset, peak, and decay of sweetness
(C) The color uniformity and surface appearance of processed cheese slices
(D) The ultimate statistical significance levels of a two-out-of-five test

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CHAPTER 11

Sensory Evaluation of Milk and Milk Products

2013

1. Which term specifically describes the evaluation of food quality based solely on human sensory organ responses rather than instrumental measurements?
(A) Organoleptic evaluation
(B) Rheological analysis
(C) Objective evaluation
(D) Spectrophotometric analysis

2007

2. Which of the following is NOT a primary type of papillae found on the human tongue involved in gustation?
(A) Fungiform
(B) Foliate
(C) Filiform
(D) Circumvallate

2016

3. In the context of olfaction, what does the lock-and-key theory primarily explain?
(A) The binding of odorants to matching olfactory receptors
(B) The flow of air currents through the nasal conchae passages
(C) The functional split of ortho-nasal and retro-nasal pathways
(D) The rate of sensory adaptation in the olfactory epithelium cells

2024

4. Which somatic sensation is mediated by the trigeminal nerve when consuming highly carbonated dairy beverages?
(A) Sweetness
(B) Umami
(C) Olfactory adaptation
(D) Pungency

2015

5. According to Weber's Law, the Just Noticeable Difference (JND) is directly proportional to which of the following?
(A) The logarithm of the stimulus intensity
(B) The initial intensity of the stimulus
(C) The square root of the stimulus magnitude
(D) The duration of the stimulus application

2003

6. What is the sensory threshold termed when a panelist can first identify the specific nature or quality of a stimulus?
(A) Detection threshold
(B) Difference threshold
(C) Recognition threshold
(D) Terminal threshold

2003

7. In texture profile analysis, cohesiveness is categorized as which type of parameter?
(A) Secondary parameter
(B) Tertiary parameter
(C) Chemical parameter
(D) Primary parameter

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2024

8. What is the primary purpose of using red lighting in a sensory testing booth during the evaluation of dairy products?
(A) To mask visual color differences among samples
(B) To actively enhance the sweet taste perception of samples
(C) To increase the ambient temperature of the booth
(D) To reduce the olfactory adaptation of panelists

2025

9. Which screening test is most appropriate for determining a candidate's physiological ability to perceive fundamental taste qualities during panelist selection?
(A) Triangle test
(B) Basic taste acuity test
(C) Hedonic scaling
(D) Quantitative Descriptive Analysis

(C) Syneresis rate
(D) Hedonic scaling

2011

48. What is the fundamental difference between objective and subjective evaluation methods in food science?
(A) Subjective methods use instruments; objective methods use human senses.
(B) Subjective methods are only used for liquid milk; objective methods are for solid dairy.
(C) Objective methods measure consumer preference; subjective methods measure chemical composition.
(D) Objective methods use instruments; subjective methods rely on human perception.

2022

49. The umami taste sensation is primarily triggered by the binding of which specific molecule to gustatory receptors?
(A) L-glutamate
(B) Sodium chloride
(C) Hydrogen ions
(D) Sucrose

2008

50. Match the somatosensory tactile sensations (List I) with their typical dairy or food trigger (List II).

List I: (Tactile sensations)
P. Astringency
Q. Cooling
R. Pungency
S. Viscosity

List II: (Typical triggers)
1. Menthol or rapid evaporation
2. High concentration of stabilizers/gums
3. Tannins or specific whey proteins in acidic environments
4. Capsaicin or high carbonation

(A) P-3, Q-1, R-4, S-2
(B) P-1, Q-3, R-2, S-4
(C) P-3, Q-4, R-1, S-2
(D) P-2, Q-1, R-4, S-3

2018

51. Which statement regarding retro-nasal olfaction is most accurate?
(A) Volatiles travel from the oral cavity to the nasopharynx during mastication.
(B) Odorants are inhaled directly through the external nares before swallowing.
(C) Aroma compounds bypass the sensory olfactory epithelium pathway entirely.
(D) Sensory signals are solely responsible for detecting the basic sweet tastes.

2021

52. Thermal perception during sensory evaluation of ice cream significantly affects flavor release because:
(A) Cold temperatures rapidly denature critical milk proteins during chewing.
(B) Elevated temperatures trigger rapid lipid oxidation during eating.
(C) Low temperatures physically alter the pathway of the trigeminal nerve.
(D) Cold temperatures suppress aroma volatility and numb taste receptors.

NODIA

2005

53. Which term describes the smallest physical increment in stimulus intensity required to produce a perceptible change in sensation?
(A) Absolute threshold
(B) Difference threshold
(C) Recognition threshold
(D) Terminal threshold

2007

54. In rheological terminology, adhesiveness is defined as the work required to:
(A) Deform a structured material to the precise point of physical fracture.
(B) Squeeze a semi-solid food material continuously between the molars.
(C) Overcome attractive forces between the food surface and the mouth.
(D) Measure the cohesive internal bonds making up the body of the product.

2006

55. Consider the following statements regarding sensory lab climate control:
I. Odor-free ventilation systems with activated carbon filters are mandatory.
II. Ambient temperature is generally maintained at 20-22°C.
III. Relative humidity is strictly maintained above 90% to enhance olfaction.
Which of the above statements is/are correct?
(A) I and III
(B) I
(C) II and III
(D) I and II

2018

56. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).

Assertion (A): Expert sensory panels consist of highly trained individuals evaluated strictly for sensory acuity and reproducibility.

Reason (R): Expert panels are primarily utilized to determine broad consumer liking and market acceptance of a new dairy product.

(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2016

57. Which error is systematically minimized by providing panelist training, standard reference samples, and randomized presentation orders?

(A) Central tendency error
(B) Psychological bias
(C) Stimulus error
(D) Physiological adaptation

2019

58. In the Duo-trio test, what is the exact probability of a panelist selecting the correct sample purely by chance?

(A) 50.0%
(B) 33.3%
(C) 25.0%
(D) 10.0%

2010

59. The 9-point Hedonic scale ranges fundamentally from:

(A) Dislike extremely to Like extremely
(B) No perceived flavor to Extreme flavor intensity
(C) Completely soft consistency to Extremely hard body
(D) Totally unacceptable to Highly acceptable quality

2007

60. Consider the following statements concerning the Texture Profile Method:

I. It requires only untrained consumer panelists.
II. It standardizes the evaluation of mechanical, geometrical, and moisture attributes.
III. It utilizes structured scales anchored with reference foods.
IV. It was initially developed strictly for evaluating liquid milk.

Which of the above statements is/are INCORRECT?

(A) I and IV
(B) I, II and IV
(C) II and III
(D) III and IV

2022

61. Which temporal sensory evaluation technique tracks the sequential presence of multiple different sensory attributes rather than just the intensity of a single attribute?

(A) Time-Intensity (TI)
(B) Quantitative Descriptive Analysis (QDA)
(C) Flavour Profile Method
(D) Temporal Dominance of Sensations (TDS)

2021

62. Match the instrumental analogue (List I) with its corresponding human sensory modality (List II).

List I: (Instrumental analogue)

P. Colorimeter
Q. Texture Analyzer
R. Electronic Nose
S. Electronic Tongue

List II: (Sensory modality)

1. Gustation
2. Somatosensation (Mechanical)
3. Olfaction
4. Vision

(A) P-4, Q-2, R-3, S-1
(B) P-3, Q-1, R-4, S-2
(C) P-4, Q-3, R-2, S-1
(D) P-1, Q-4, R-2, S-3

2003

63. Which specific off-flavor in liquid milk is most definitively traced to the accumulation of which compounds?

(A) Oxidized phospholipids
(B) Free fatty acids
(C) Peptides from proteolysis
(D) Lactic acid

2024

64. Mottling in butter is primarily classified as which type of defect?

(A) Standard flavor defect
(B) Off-odor defect
(C) Structural packaging defect
(D) Appearance defect

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2025

65. Consider the following statements regarding Mozzarella cheese evaluation:

I. Excellent stretchability upon heating is a critical primary parameter.

II. A highly crumbly texture is desired in fresh Mozzarella.

III. Oil-off (free oil formation) must be excessive for high-quality pizza applications.

IV. The flavor should be mild, slightly acidic, and milky.

V. Extensive eye-formation is characteristic of traditional Mozzarella.

Which of the above statements is/are correct?

(A) I, II and V
(B) I and IV
(C) II, III and V
(D) I, III and IV

2006

66. During meltdown evaluation of ice cream, a curdy appearance as the product melts usually indicates:

(A) High quality stabilization
(B) Excessive sweetness
(C) Protein destabilization
(D) The use of high-quality vanilla extract

2013

67. Which of the following best describes a high-quality traditional Peda?

(A) Mildly caramelized flavor with a cohesive body
(B) Granular texture with a pale white color and salty flavor
(C) Spongy, highly elastic texture with strong yeasty aroma
(D) Fluid consistency with a pronounced cooked flavor

2007

68. Consider the following statements regarding Chhana defects:

I. A sour flavor indicates delayed coagulation or improper cooling.

II. A soft and smooth body is considered a severe textural defect.

III. High moisture content significantly extends the shelf life.

Which of the above statements is/are INCORRECT?

(A) II and III
(B) I and II
(C) I
(D) I and III

2010

69. Assessing syneresis in set Yoghurt primarily evaluates which structural aspect?

(A) The fermentation rate of lactose
(B) Casein gel network stability
(C) The degree of lipid oxidation
(D) The amount of added sugar

2019

70. Which of the following represents the correct sequence of perceived sensations during the mastication of a firm cheese?

(A) Flavor release, Initial bite hardness, Cohesiveness during chewing, Residual mouthfeel
(B) Residual mouthfeel, Initial bite hardness, Flavor release, Cohesiveness during chewing
(C) Initial bite hardness, Cohesiveness during chewing, Flavor release, Residual mouthfeel
(D) Cohesiveness during chewing, Flavor release, Initial bite hardness, Residual mouthfeel

2016

71. A stale flavor in dry milk powder is often a precursor to which more severe defect during extended storage?

(A) Malty flavor
(B) Lipolyzed flavor
(C) Cooked flavor
(D) Oxidized flavor

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2002

72. Which term is used to describe the sensory testing design where presentation order is completely randomized across all panelists to mitigate order bias?

(A) Latin square design
(B) Sequential balancing
(C) Complete block design
(D) Factorial design

2007

73. Which type of papillae located at the back of the tongue houses the largest concentration of taste buds?

(A) Anterior fungiform papillae
(B) Circumvallate papillae
(C) Lateral foliate papillae
(D) Non-gustatory filiform papillae

2006

74. Consider the following statements regarding basic tastes and their typical transduction mechanisms:

I. Salty - Depolarization via sodium ion channels

2008

38. The Electronic Tongue (E-tongue) utilizes which type of technology to mimic human gustation in liquid dairy samples?
(A) Gas chromatography coupled with mass spectrometry systems
(B) High-resolution ultraviolet spectrophotometry
(C) Ion-selective potentiometric sensors
(D) Near-infrared reflectance spectroscopy instruments

2005

39. Which flavor defect in liquid milk is associated with bacterial degradation of proteins forming volatile compounds?
(A) Lipolyzed
(B) Light-activated
(C) Flat
(D) Putrid/Fruity

2009

40. Select the correct sequence of the standard physiological mechanisms in odor perception via the ortho-nasal route.
(A) Inhalation, Mucus dissolution, Receptor binding, Olfactory bulb transmission
(B) Receptor binding, Mucus dissolution, Inhalation, Olfactory bulb transmission
(C) Inhalation, Receptor binding, Mucus dissolution, Olfactory bulb transmission
(D) Mucus dissolution, Inhalation, Olfactory bulb transmission, Receptor binding

2010

41. A crumbly body in butter is most often the result of which processing error?
(A) Overworking the butter cream during processing at excessively high temperatures
(B) Improper cooling temperature leading to large fat crystals
(C) Inadequate washing of the butter granules to remove buttermilk residues
(D) Insufficient salting and distribution during the final physical working stage

2018

42. Arrange the typical progressive stages of perceived cheese flavor development during Cheddar ripening in the correct chronological order:
I. Mild, slightly sweet
II. Sharp, fully developed sulfur notes
III. Mellow, balanced savory notes
IV. Curdy, bland
(A) IV, I, III, II
(B) I, IV, II, III
(C) IV, III, I, II
(D) I, II, III, IV

2003

43. Fluffiness in ice cream, characterized by a spongy texture that melts down poorly, is typically caused by:
(A) Excessive overrun
(B) Insufficient overrun
(C) High lactose content
(D) Low fat content

2012

44. Which indigenous dairy product is traditionally evaluated for a slightly granular texture and a distinct caramelized flavor?
(A) Shrikhand
(B) Peda
(C) Khoa
(D) Paneer

2004

45. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): Chhana used for making premium Rasogolla should have a hard and firm texture.
Reason (R): Hard Chhana lacks elasticity and cohesiveness, preventing the formation of smooth, spongy balls during cooking.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2023

46. A yeasty flavor in Dahi is considered a severe defect because it indicates:
(A) Standard lactic acid fermentation by optimal starter cultures
(B) Excessive butterfat content in the raw milk starting material
(C) Contamination with yeasts producing ethanol and gassy off-flavor development
(D) The use of ultra-high treatment during pasteurization

2012

47. Which evaluation metric is specifically used to measure the reconstitution property of milk powder visually and physically?
(A) Viscosity profile
(B) Wettability index

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(D) Four match type A, one matches type B; probability is 20%

2019
82. Which scaling method relies on the panelist placing a mark on a 15-cm horizontal line anchored with descriptive terms at either end?
(A) Standard 9-point Hedonic scale
(B) Categorical ranking scale
(C) Line scale (Unstructured)
(D) Ratio magnitude estimation scale

2018
83. The Flavour Profile Method uniquely evaluates flavor attributes based on their:
(A) Appearance order, intensity, aftertaste, and amplitude
(B) Visual color masking properties under colored light booths
(C) Structural syneresis rate during active mastication
(D) Ultrasonic acoustic emissions generated during initial biting

2013
84. Temporal Dominance of Sensations (TDS) requires panelists to:
(A) Quantitatively rate the absolute intensity of all sensory attributes simultaneously
(B) Measure the exact temporal duration of the sensory aftertaste only
(C) Identify the single odd sample out of three at different time intervals
(D) Select the single dominant sensory attribute over time

2017
85. Consider the following statements regarding the Electronic Nose:
I. It analyzes the headspace volatiles of a sample.
II. It directly measures the exact molecular weight of each odorant.
III. It relies on pattern recognition software like Principal Component Analysis (PCA).
Which of the above statements is/are INCORRECT?
(A) II
(B) I and III
(C) I and II
(D) III

2018
86. Select the correct sequence of actions for a panelist evaluating the flavor of liquid milk.
(A) Take a large gulp, Smell the empty cup, Roll over the tongue, Note aftertaste
(B) Expectorate, Smell the headspace, Take a small sip, Roll over the tongue
(C) Smell the headspace, Take a small sip, Roll over the tongue, Expectorate/Swallow, Note aftertaste
(D) Note aftertaste, Smell the headspace, Take a small sip, Swallow rapidly

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2011
87. A malty flavor in raw milk is almost exclusively an indication of:
(A) Accidental trace copper metal contamination during processing
(B) Excessive exposure to fluorescent or ultraviolet sunlight
(C) Dairy cattle actively grazing on wild pasture onions or garlic
(D) Growth of Lactococcus lactis var. maltigenes

2012
88. In the evaluation of fat-rich dairy products, a "sticky" defect refers to butter that:
(A) Adheres to the palate and utensils
(B) Crumbles apart easily during the spreading process
(C) Exhibits an excessive degree of free water droplets on its surface
(D) Emits a distinctly sour, fermented chemical odor

2005
89. Eye-formation is a critical grading parameter for which specific cheese variety?
(A) Aged Cheddar
(B) Emmental
(C) Fresh Mozzarella
(D) Soft Cream Cheese

2011
90. Consider the following statements concerning ice cream sensory evaluation:
I. Iciness is a defect caused by large ice crystals forming due to temperature fluctuations.
II. A gummy texture indicates excessive use of stabilizers.
III. Excellent meltdown means the ice cream retains its exact solid shape at room temperature for hours.
IV. Fluffiness is highly desirable in premium, low-overrun ice creams.
Which of the above statements is/are correct?
(A) I and II
(B) II, III and IV
(C) I, II and III

2024
149. The error of central tendency is most prevalent when panelists:
(A) Lack familiarity with the evaluation products and confidence
(B) Are required to evaluate an uneven, odd number of samples
(C) Have achieved highly advanced levels of sensory expertise
(D) Experience significant levels of physiological adaptation

2019
150. A Triangle test requires the panelist to identify the:
(A) Most preferred sample
(B) Sample with the strongest specific attribute
(C) Two samples that are identical
(D) Odd sample out of three

2009
151. Which statement best defines an unstructured line scale?
(A) A scale containing discrete numerical intervals ranging from 1 to 9
(B) A continuous line with descriptive end-anchors and no mid-divisions
(C) A comparative scale designed to rank multiple products from first to last
(D) A psychological scale measuring the subjective emotional response to food

2006
152. In the Flavour Profile Method, what does the term "Amplitude" refer to?
(A) The maximum peak force measured on a texture analyzer
(B) The specific intensity of the strongest sweet compound
(C) The overall balance and blending of the key flavor notes
(D) The statistical variance calculated from the panel scores

2004
153. Which advanced technique is uniquely suited to visualize which specific sensory attribute is most noticeable at every precise second during mastication?
(A) Quantitative Hedonic Rating
(B) Triangle Difference Testing
(C) Multi-dimensional Preference Mapping
(D) Temporal Dominance of Sensations (TDS)

2017
154. E-nose systems commonly utilize Principal Component Analysis (PCA) to:
(A) Reduce complex multi-sensor data into 2D or 3D plots
(B) Increase volatile concentration in the sample headspace
(C) Purge and clean sensor arrays between sample runs
(D) Synthesize and identify artificial flavor compounds

2001
155. A "flat" flavor in liquid milk is most commonly caused by:
(A) Applying excessive thermal pasteurization or sterilization
(B) Having low solids, low fat, or dilution with water
(C) Promoting rapid bacterial fermentation of milk lactose
(D) Introducing strong volatile feed flavors like wild onion

2014
156. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): Evaluating butter at refrigerator temperature (4°C) provides the most accurate assessment of its flavor profile.
Reason (R): Volatility of flavor compounds increases at higher temperatures, and tempering butter to around 13°C or warming it in the mouth is essential for full flavor volatilization.
In the light of the above statements, choose the correct answer from the options given below:
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2023
157. Which cheese defect is characterized by the formation of deep, irregular splits or cracks within the body rather than smooth, round eyes?
(A) Slit or mechanical openness
(B) Severe late gas blowing
(C) Excessively dry corkiness
(D) Crumbly and weak texture

2022
158. Meltdown quality in ice cream is visually evaluated by allowing a standard volume to

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III. Detection Threshold
IV. Recognition Threshold
Which of the following represents the typical chronological order of perception as stimulus concentration incrementally increases from zero?
(A) III, IV, I, II
(B) III, I, IV, II
(C) IV, III, I, II
(D) I, III, IV, II

2014
101. Which texture parameter is calculated as the ratio of the work done during the second compression to the work done during the first compression in TPA?
(A) Springiness
(B) Cohesiveness
(C) Chewiness
(D) Gumminess

2017
102. An ISO standard sensory testing booth recommends maintaining ambient noise levels below what threshold to prevent distraction?
(A) 80 dB
(B) 60 dB
(C) 40 dB
(D) 20 dB

2013
103. Which panelist screening protocol evaluates a candidate's ability to consistently rank a series of basic taste solutions of varying concentrations?
(A) Matching test
(B) Triangle test
(C) Recognition test
(D) Ranking test

2022
104. Which psychological error occurs when panelists deliberately avoid using the extreme ends of a rating scale, artificially compressing the data?
(A) Central tendency error
(B) Systematic leniency error
(C) Sequential contrast effect
(D) Attribute-based halo effect

2022
105. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): Paired-comparison tests can be directional or non-directional.
Reason (R): In a directional test, panelists simply identify if the two samples are different, whereas in a non-directional test, they must identify which sample possesses a specified attribute more intensely.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2019
106. In sensory evaluation, structured scoring scales differ from unstructured scales primarily because structured scales:
(A) Are specifically designed to be used only by untrained consumer panelists
(B) Contain discrete numbers or defined categories at intervals
(C) Absolutely do not anchor the outer ends of the response scale
(D) Are functionally restricted to only measure product texture attributes

2011
107. Quantitative Descriptive Analysis (QDA) utilizes which unique graphical format to present the sensory profile consensus of a product?
(A) Radar plot
(B) Bar chart
(C) Scatter plot
(D) Histogram

2003
108. In Time-Intensity (TI) analysis, which parameter mathematically represents the highest level of sensation perceived during the evaluation period?
(A) Time to peak ($T_{\max}$)
(B) Area under the curve (AUC)
(C) Maximum intensity ($I_{\max}$)
(D) Decay rate

2007
109. Which sensing technology is predominantly utilized in the Electronic Nose to detect volatile organic compounds?
(A) Potentiometric electrodes
(B) High-performance liquid chromatography
(C) Electrophoresis gels
(D) Metal oxide semiconductor (MOS) sensors

2014
110. Match the milk off-flavor (List I) with its most likely primary cause (List II).
List I: (Milk off-flavor)
P. Oxidized
Q. Rancid

NODIA

(D) I and IV

2011

91. Which volatile flavor compound is primarily responsible for the desirable, characteristic rich, buttery aroma of high-quality Ghee?
(A) Diacetyl
(B) Acetaldehyde
(C) Ethyl butyrate
(D) Methional

2019

92. Consider the following steps for conducting an objective Texture Profile Analysis (TPA) using a texture analyzer:
I. Position the standardized food sample on the testing platform.
II. Generate the force-time deformation curve.
III. Compress the sample with a probe twice (two-bite test).
IV. Calculate parameters like hardness, springiness, and cohesiveness from the curve.
Which of the following represents the correct sequence of steps?
(A) I, III, II, IV
(B) I, II, III, IV
(C) III, I, II, IV
(D) I, III, IV, II

2014

93. Over-sourness in Yoghurt is predominantly due to the continued metabolic activity of the starter cultures producing excessive amounts of:
(A) Citric acid
(B) Acetic acid
(C) Propionic acid
(D) Lactic acid

2016

94. Reconstitution properties of milk powder are negatively affected if the powder undergoes which physical defect?
(A) Maillard browning
(B) Lipolysis
(C) Caking
(D) Syneresis

2021

95. Consider the following statements concerning the differences between Subjective and Objective evaluation:
I. Subjective methods measure consumer acceptance.
II. Objective methods rely heavily on the physiological state of the instrument operator.
III. Subjective methods require standardization and controlled environments.
IV. Objective methods measure physical, chemical, or rheological properties directly.
V. Subjective and objective methods are mutually exclusive and never correlate.
Which of the above statements is/are correct?
(A) I, III and IV
(B) II, III and V
(C) I, II and IV
(D) I, IV and V

2001

96. Which cranial nerves are directly responsible for transmitting gustatory signals from the taste buds to the brain?
(A) Olfactory (I), Optic (II), and Trigeminal (V)
(B) Trigeminal (V), Glossopharyngeal (IX), and Hypoglossal (XII)
(C) Auditory (VIII), Accessory (XI), and Vagus (X)
(D) Facial (VII), Glossopharyngeal (IX), and Vagus (X)

2022

97. Which specific class of membrane proteins acts as the primary receptors for sweet, bitter, and umami taste sensations?
(A) Ionotropic receptor channels
(B) G-protein coupled receptors (GPCRs)
(C) Receptor tyrosine kinases
(D) Voltage-gated calcium channels

2016

98. Astringency in dairy products, such as acid whey, is predominantly perceived as a feeling of:
(A) An intense feeling of hotness or thermal burning on the tongue
(B) Extreme initial sweetness followed by a lingering bitter aftertaste
(C) Puckeriness and drying of oral surfaces
(D) A refreshing cooling sensation located in the back of the throat

2004

99. The concept that equal stimulus ratios produce equal sensation intervals is best attributed to:
(A) Fechner's Law
(B) Weber's Law
(C) Stevens' Power Law
(D) Beidler's Equation

2021

100. Consider the following sensory thresholds:
I. Difference Threshold
II. Terminal Threshold

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2021

120. Somatosensory input during food consumption is transmitted primarily via which nerve pathway?
(A) Vagus nerve
(B) Optic nerve
(C) Trigeminal nerve
(D) Auditory nerve

2010

121. In psychophysics, an exponent of less than 1.0 in Stevens' Power Law indicates what relationship between stimulus and sensation?
(A) Response expansion (sensation grows faster than stimulus)
(B) Linear relationship (sensation grows at a constant rate)
(C) Absolute threshold (sensation remains at zero baseline)
(D) Response compression (sensation grows slower than stimulus)

2024

122. The difference threshold or JND is a dynamic value that typically:
(A) Increases as the background stimulus intensity increases
(B) Remains constant regardless of stimulus intensity
(C) Decreases as the background stimulus intensity increases
(D) Is always 10% of the terminal threshold

2006

123. Which texture parameter is evaluated by determining the extent to which a food sample recovers its original height after the initial deforming force is removed?
(A) Hardness
(B) Springiness
(C) Adhesiveness
(D) Chewiness

2010

124. Consider the following statements concerning sensory laboratory design:
I. Booth walls should be painted with highly saturated, bright colors to stimulate panelists.
II. A pass-through hatch is necessary to serve samples without panelist-operator interaction.
III. Lighting should ideally be adjustable, including the ability to provide colored light.
IV. Positive air pressure in booths prevents external odors from entering.
Which of the above statement(s) is/are correct?
(A) II, III and IV
(B) I, II and III
(C) I and IV
(D) II and IV

2001

125. When screening a trained sensory panel, the "acuity test" specifically ensures the panelist can:
(A) Detect and recognize basic tastes and odors at low concentrations
(B) Formulate comprehensive product descriptions and profile vocabularies
(C) Calculate standard deviations and statistical variances of panel scores
(D) Correctly identify the odd sample in discriminative tests every time

2021

126. The "halo effect" is a psychological bias that is best prevented by:
(A) Presenting all sensory attributes simultaneously on a single evaluation page
(B) Providing test samples featuring highly visible commercial branding
(C) Evaluating only one attribute per session or separating questions sequentially
(D) Presenting highly detailed verbal descriptions of the product before testing

2009

127. If an experiment requires identifying whether a small reformulation has detectably altered a dairy beverage, the most statistically powerful discriminative test to use is the:
(A) Duo-trio test
(B) Simple A-Not A test
(C) Paired-comparison test
(D) Triangle test

2016

128. A panelist assigns a score of 7 on a 9-point Hedonic scale. What verbal anchor does this score correspond to?
(A) Like moderately
(B) Like very much
(C) Neither like nor dislike
(D) Dislike slightly

2024

129. Which sensory methodology relies on establishing a standardized vocabulary through panel consensus and evaluating intensity using an unstructured line scale?
(A) Texture Profile Method
(B) Quantitative Descriptive Analysis

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R. Malty
S. Flat

List II: (Primary cause)

1. Hydrolysis of milk fat by lipase
2. Low total solids or addition of water
3. Copper-catalyzed lipid auto-oxidation
4. Bacterial contamination during poor cooling

(A) P-3, Q-1, R-4, S-2
(B) P-1, Q-3, R-2, S-4
(C) P-3, Q-2, R-4, S-1
(D) P-2, Q-1, R-3, S-4

2010

111. Leakiness in butter is a visual and textural defect most directly indicating:
(A) An excessively high salt content leading to moisture migration
(B) Poor water droplet dispersion during working
(C) An exceptionally high percentage of butterfat in the cream
(D) Advanced lipid oxidation of unsaturated fatty acid chains

2021

112. Which flavor defect in Mozzarella cheese is often attributed to the use of poor quality, highly acidic milk or excessive starter culture activity?
(A) Bitter flavor
(B) Flat/tasteless
(C) Highly oxidized
(D) Sour

2009

113. Ice cream evaluation panel notes a "coarse" texture. This defect is fundamentally a milder form of:
(A) Iciness
(B) Fluffiness
(C) Sandiness
(D) Gumminess

2003

114. Khoa quality is heavily dependent on the type of milk used. Khoa made from buffalo milk is generally preferred over cow milk because it yields a product with:
(A) Significantly lower total butterfat content
(B) A distinctly bright yellow color from high beta-carotene
(C) A whiter color and a more desirable granular texture
(D) Greater physiological susceptibility to Maillard browning

NODIA

2011

115. Paneer evaluation differs from Chhana evaluation primarily because Paneer must possess:
(A) A firm block structure that can be sliced easily
(B) A highly granular, loose, and crumbly structural matrix
(C) Extremely high titratable acidity levels to develop taste
(D) A pronounced cooked, caramelized flavor from intense heating

2011

116. Shrikhand evaluation emphasizes which combination of primary sensory attributes?
(A) Strong saltiness, crumbly texture, and a highly dry, flaky body
(B) Intense bitterness, high effervescence, and a sharp, carbonated taste
(C) Sweet-sour balance, distinct cardamom flavor, and a smooth, semi-solid body
(D) High liquid consistency, strong cooked flavor, and a greasy surface film

2011

117. Which parameter of evaporated milk is visually assessed by rotating the can and observing the product film left on the glass during transfer?
(A) Viscosity and uniformity
(B) Acidity and sourness
(C) Caramelized off-flavor
(D) Sandiness and grittiness

2024

118. Consider the following pairings of basic tastes with their generalized biological warning or reward functions:
I. Sweet - Caloric/energy reward
II. Bitter - Toxin avoidance
III. Sour - Spoilage or unripe warning
Which of the above statement(s) is/are correct?
(A) I and II
(B) II and III
(C) I, II and III
(D) I and III

2009

119. Ortho-nasal olfaction differs from retro-nasal olfaction in that ortho-nasal perception:
(A) Evaluates the flavor of food during mastication
(B) Detects odorants inhaled through the nostrils
(C) Entirely bypasses the nasal cavity pathways
(D) Relies purely on objective instrumentation

(C) Highly rancid and hydrolytic butyric odor
(D) Extremely high powder wettability defects

2014

140. Match the subjective sensory terms in List I with their corresponding objective or rheological terms in List II:

List I: (Subjective Sensory Term)
P. Thickness
Q. Firmness
R. Bounciness
S. Stickiness

List II: (Objective/Rheological Term)
1. Hardness
2. Springiness
3. Viscosity
4. Adhesiveness

(A) P-1, Q-3, R-4, S-2
(B) P-3, Q-1, R-2, S-4
(C) P-3, Q-4, R-2, S-1
(D) P-2, Q-1, R-3, S-4

2003

141. The specific area of the brain that serves as the primary gustatory cortex, processing taste signals, is the:
(A) Insula and frontal operculum
(B) Cerebellum and pons region
(C) Occipital lobe and visual zone
(D) Hippocampus and amygdala complex

2010

142. The "ortho-nasal" and "retro-nasal" routes of olfaction typically produce different intensity perceptions of the same food because:
(A) Receptors located in the two distinct nasal pathways are structurally different
(B) Ortho-nasal pathways stimulate the trigeminal nerves, whereas retro-nasal do not
(C) Retro-nasal pathways are influenced by mastication, temperature, and saliva
(D) Retro-nasal pathways exclusively detect high-molecular weight volatiles

2018

143. Which trigeminal sensation is commonly associated with the consumption of aged, sharp Cheddar cheese?
(A) Extreme physiological cooling
(B) Intense localized oral numbing
(C) Strong, burning chemical heat
(D) Mild trigeminal pungency or bite

2013

144. In Weber's Law, mathematically defined as $\frac{\Delta I}{I} = K$, what does K represent?
(A) The absolute sensory threshold value
(B) The physical intensity of the stimulus
(C) The Weber fraction representing a constant
(D) The terminal maximum sensation limit

2007

145. The recognition threshold is invariably:
(A) Significantly lower than the detection threshold
(B) Higher than or equal to the detection threshold
(C) Exactly equal to the maximum terminal threshold
(D) Completely unrelated to stimulus concentration

2022

146. Which fundamental rheological property describes a material that exhibits both solid-like elastic recovery and liquid-like viscous flow?
(A) Pure elasticity
(B) Newtonian fluidity
(C) Plasticity
(D) Viscoelasticity

2018

147. A primary ISO recommendation for sensory booth lighting to mask minor color differences in dairy beverages is the use of:
(A) Monochromatic sodium vapor or colored red lighting
(B) Standard high-intensity blue light filter systems
(C) Low-intensity long-wavelength ultraviolet source
(D) Focused high-output directional halogen spotlights

2005

148. Which factor is considered an unacceptable physiological condition for a panelist right before a sensory evaluation session?
(A) Drinking standard room-temperature purified water
(B) Experiencing a state of mild, non-distracting hunger
(C) Consuming spicy food or smoking within fifteen minutes
(D) Resting quietly in the designated panel waiting area

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(C) Flavour Profile Method
(D) Ranking test

2016

130. Consider the following events during a Time-Intensity (TI) sensory evaluation of sweetness:
I. Sweetness intensity increases to a peak.
II. Panelist places the sample in the mouth.
III. Sweetness intensity decays to zero.
IV. Panelist expectorates or swallows the sample.
Which of the following is the correct chronological sequence of these events?
(A) II, I, IV, III
(B) I, II, III, IV
(C) II, IV, I, III
(D) IV, II, I, III

2021

131. The primary operational component of an Electronic Tongue (E-tongue) that interacts with the sample matrix is the:
(A) Sensor array
(B) Capillary column
(C) Refractometer
(D) Spectrophotometric cell

2017

132. The ADSA score card allocates the maximum possible points to which sensory parameter of liquid milk?
(A) Body and Texture
(B) Appearance
(C) Flavor
(D) Color

2009

133. Which sensory defect in butter is characterized by an uneven, patchy color distribution?
(A) Mottling
(B) Crumbly
(C) Leakiness
(D) Sticky

2022

134. A Cheddar cheese sample is evaluated and found to possess a distinct "corky" texture. This indicates the cheese is:
(A) Excessively high in moisture and surface wetness
(B) Lacking sufficient internal elasticity and firmness
(C) Completely full of uniform, small mechanical gas holes
(D) Excessively dry, hard, and lacking in cohesiveness

2015

135. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): Ice cream evaluated immediately after drawing from the batch freezer has better meltdown characteristics than after hardening.
Reason (R): Hardening promotes the formation of a rigid ice crystal network and stabilizes the fat-protein matrix, extending the meltdown time.
In the light of the above statements, choose the correct answer from the options given below:
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2002

136. When grading Peda, a "sticky" or "chewy" texture is generally considered a defect resulting from:
(A) Inadequate heating and low sugar addition
(B) Using raw, unpasteurized buffalo milk
(C) Over-boiling and high sugar concentration
(D) Extremely low butterfat content in milk

2008

137. Which texturizer naturally provides the characteristic elasticity and chewiness required for good quality Paneer?
(A) Cross-linked starches added during the standardization stage
(B) Refined carrageenan gums introduced before the heating phase
(C) Large lactose crystals formed during the cooling process
(D) Casein micelle networks formed by heat and acid coagulation

NODIA

2007

138. The appearance of "wheying off" (syneresis) on the surface of set Dahi is sensorially evaluated as a defect in:
(A) Body and texture/appearance
(B) Flavor and aroma profile
(C) Odor and volatile bouquet
(D) Nutritional/chemical quality

2010

139. Evaporated milk that has been subjected to excessive heat treatment during sterilization is most likely to exhibit which sensory defect?
(A) Pronounced malty and feed-associated flavor
(B) Strong caramelized flavor and darker color

melt at room temperature on a mesh screen. A desirable meltdown should appear:
(A) Highly foamy and stable, retaining its physical shape indefinitely
(B) Extremely clear, watery, and showing rapid fluid drainage
(C) Smooth, uniform, and resembling the original unfrozen mix
(D) Curdy, unstable, and clearly separated into whey and fat phases

2021
159. When Khoa exhibits a "rancid" flavor, it strongly indicates that the product:
(A) Suffered extensive overcooking and caramelization during desiccation
(B) Contains excessive amounts of added sucrose and sugar crystallizations
(C) Was manufactured using low-grade skim milk with minimal fat
(D) Underwent lipolysis from residual lipase activity or microbes

2002
160. Which processing step is most critical in determining the final body and texture (e.g., spongy vs. firm) of heat-acid coagulated products like Chhana and Paneer?
(A) The exact type of acidulant used
(B) The duration of cold storage post-production
(C) The coagulation temperature and pH
(D) The color of the raw milk

2022
161. Over-sourness in Dahi is a defect resulting from extended fermentation times or poor cooling, which causes the pH to drop below optimal levels. What is the typical optimal pH for set Dahi?
(A) 6.0 - 6.2
(B) 5.2 - 5.5
(C) 4.4 - 4.6
(D) 3.0 - 3.5

2009
162. Match the dairy products in List I with their corresponding standard sensory evaluation scorecard features in List II:
List I: (Dairy Product)
P. Liquid Milk
Q. Ice Cream
R. Butter
S. Cheddar Cheese
List II: (Sensory Evaluation Scorecard Feature)
1. Evaluates eye-formation and sharp flavor notes
2. Maximum score often allocated to flavor, heavily penalizes oxidized notes
3. Includes evaluation of meltdown and iciness
4. Evaluates spreadability and mottling
(A) P-3, Q-1, R-4, S-2
(B) P-1, Q-2, R-3, S-4
(C) P-2, Q-4, R-1, S-3
(D) P-2, Q-3, R-4, S-1

2003
163. Which term best characterizes the subjective evaluation of food acceptability based solely on individual preference?
(A) Affective (Hedonic) testing
(B) Analytical (Objective) testing
(C) Discriminative (Difference) testing
(D) Descriptive (Profiling) testing

2003
164. The basic taste "sour" is fundamentally a physiological response to the presence of:
(A) Simple sugars and carbohydrates
(B) Basic alkaloids and nitrogenous bases
(C) Hydrogen ions (hydronium protons)
(D) Free fatty acids and short lipids

2013
165. The olfactory epithelium is located in which specific anatomical region?
(A) The roof of the nasal cavity
(B) The anterior tip of the tongue
(C) The posterior wall of the pharynx
(D) The central area of the hard palate

2016
166. Which tactile sensation is perceived when evaluating high-fat dairy products like cream or butter in the oral cavity?
(A) Distinct astringency
(B) Trigeminal pungency
(C) Physiological cooling
(D) Creamy coating/mouthfeel

2004
167. Fechner's Law assumes that the magnitude of sensation increases arithmetically as the physical stimulus intensity increases:
(A) In a linear manner
(B) In a logarithmic manner
(C) In an exponential manner
(D) In an inverse manner

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2002

168. If a panelist requires a higher concentration of salt to detect saltiness in a cheese sample than they did yesterday, their detection threshold has:
(A) Decreased
(B) Remained constant
(C) Increased
(D) Reached the terminal limit

2001

169. In sensory terminology, what describes the mechanical parameter reflecting the degree to which a food sample can be deformed before it ruptures?
(A) Adhesiveness
(B) Hardness
(C) Viscosity
(D) Cohesiveness

2008

170. According to ISO standards, which material is highly discouraged for constructing sensory booth countertops due to its potential to retain odors?
(A) Untreated wood
(B) Stainless steel
(C) Formica (laminate)
(D) Odorless acrylic

2007

171. A "consumer panel" differs from a "trained panel" primarily because the consumer panel:
(A) Identifies and evaluates specific attribute intensities
(B) Assesses overall product liking, acceptance, or preference
(C) Consists of small groups of highly calibrated individuals
(D) Employs highly complex unstructured line scales exclusively

2008

172. Which bias occurs when a panelist alters their true sensory response to align with the vocalized opinions of other panelists?
(A) The halo effect
(B) Group convergence
(C) Expectation error
(D) The stimulus error

2022

173. The Paired-comparison test is statistically evaluated using which distribution model?
(A) Binomial distribution
(B) Poisson distribution
(C) Exponential distribution
(D) Uniform distribution

2005

174. Which scaling technique asks panelists to assign a number to the intensity of an attribute such that the ratio of numbers matches the ratio of perceived intensities?
(A) Category scaling
(B) Hedonic scaling
(C) Magnitude estimation
(D) Ranking

2016

175. Which analytical tool is heavily utilized to evaluate the complex, multidimensional data generated by a Quantitative Descriptive Analysis (QDA) panel?
(A) Simple linear regression models
(B) Chi-square tests of goodness of fit
(C) Student t-test comparative analysis
(D) ANOVA and PCA multivariate techniques

2012

176. Time-Intensity (TI) sensory data is commonly displayed on a graph plotting:
(A) Time on the Y-axis and Concentration on the X-axis
(B) Liking on the Y-axis and Attribute intensity on the X-axis
(C) Attribute intensity on the Y-axis and Time on the X-axis
(D) Frequency of dominance on the Y-axis and Time on the X-axis

2024

177. The Electronic Tongue distinguishes between different complex dairy samples primarily by:
(A) Identifying specific pathogenic strains of bacteria
(B) Generating a distinct electrochemical fingerprint
(C) Measuring the exact physical viscosity of the liquid
(D) Quantifying the total titratable acidity values

NODIA

2015

178. Which light wavelength range is primarily responsible for the "light-activated" oxidized flavor in milk packed in transparent containers?
(A) High infrared spectrum (>700 nm)
(B) Visible yellow spectrum (570-590 nm)
(C) Microwave radiation zone (>1 mm)
(D) Ultraviolet and blue light (<500 nm)

2008

179. A sensory judge evaluates butter and notes a "yeasty" or "cheesy" flavor. This defect is generally caused by:
(A) Microbial growth in the cream before churning
(B) Pure chemical oxidation of standard butterfat
(C) Excessive speed during the butter churning process
(D) High concentrations of natural beta-carotene pigment

2007

180. The ideal body and texture of Cheddar cheese is best described as:
(A) Highly granular, crumbly, and excessively dry
(B) Extremely soft, spreadable, and slightly sticky
(C) Smooth, firm, waxy, and free of mechanical openings
(D) Highly elastic and rubbery with large round gas holes

2023

181. Which common ice cream flavor defect results from utilizing whey powder of inferior quality or in excessive amounts in the mix formulation?
(A) Salty/Whey flavor
(B) Oxidized
(C) Cooked
(D) Unnatural vanilla

2012

182. A dark brown color in Peda is evaluated as a defect if it is intended to be a white variety. This excessive browning is accelerated by:
(A) Adding sugar crystals at the very end of processing
(B) Maintaining low boiling temperatures during desiccation
(C) Adding high amounts of ground cardamom seed powders
(D) High starting milk acidity promoting Maillard browning

2002

183. When evaluating Paneer, a "spongy" texture is considered a defect. This usually occurs when:
(A) The coagulation temperature applied is extremely high
(B) The starting milk is acidic or fermented before boiling
(C) The mechanical pressing weight applied is excessively high
(D) Standard buffalo milk is used instead of fresh cow milk

2025

184. In yogurt sensory evaluation, the characteristic green-apple-like flavor is primarily attributed to the presence of which volatile compound?
(A) Diacetyl
(B) Acetaldehyde
(C) Ethyl butyrate
(D) Acetoin

2006

185. The "caking" defect in milk powder during storage is physically initiated by:
(A) Auto-oxidation of lipid fractions during storage
(B) Thermal denaturation of whey proteins during drying
(C) Enzymatic breakdown of micellar casein by proteases
(D) Crystallization of lactose upon moisture absorption

2023

186. Which characteristic fundamentally separates analytical (objective) sensory testing from affective (subjective) testing?
(A) Analytical testing treats the panelist as an instrument
(B) Analytical testing relies on large groups of consumers
(C) Affective testing determines absolute sensory thresholds
(D) Analytical testing focuses heavily on packaging designs

2025

187. The bitter taste modality is uniquely critical from an evolutionary perspective because it functions primarily as a:
(A) Marker indicating high dietary caloric density
(B) Warning mechanism against toxic compounds
(C) Physiological stimulant for saliva production
(D) Detection pathway for essential amino acids

2015

188. Which structure within the nasal cavity dramatically increases the surface area for odorant detection?
(A) Nasal septum
(B) Olfactory cilia
(C) Vomeronasal organ
(D) Hard palate

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taste qualities. Advanced pattern recognition software then processes these electrical signals to classify and compare the sensory profiles of products.

39. (D) Putrid/Fruity
A putrid or fruity off-flavor in liquid milk is caused by the bacterial degradation of milk proteins and lipids. Psychrotrophic bacteria, such as Pseudomonas species, grow during cold storage and secrete extracellular enzymes that break down caseins into volatile, foul-smelling sulfur compounds and esters, indicating significant microbial contamination and shelf-life termination.

40. (A) Inhalation, Mucus dissolution, Receptor binding, Olfactory bulb transmission
The physiological process of odor perception via the ortho-nasal route begins with the inhalation of volatile compounds through the external nostrils. These compounds dissolve in the mucus layer of the olfactory mucosa. Next, they bind to matching olfactory receptors on sensory cilia, triggering electrical signals that are transmitted along the olfactory nerve to the olfactory bulb.

41. (B) Improper cooling temperature leading to large fat crystals
A crumbly body defect in butter often results from improper cooling temperatures during cream crystallization. If the cream is cooled too slowly or held at incorrect temperatures, it leads to the formation of excessively large fat crystals and a low ratio of liquid to solid fat. This prevents cohesive bonding during working, making the butter fall apart.

42. (A) IV, I, III, II
Cheddar cheese flavor changes progressively during the ripening process. Fresh cheese initially exhibits a curdy, bland sensory profile. Over time, proteolysis and lipolysis initiate, yielding a mild, slightly sweet character. Continued enzymatic breakdown develops mellow, balanced savory notes, which eventually culminate in a sharp, fully developed flavor featuring characteristic sulfur-containing volatile compounds.

43. (A) Excessive overrun
Fluffiness in ice cream is a textural defect characterized by a spongy, light, and airy body that exhibits poor meltdown performance. This is typically caused by incorporating excessive overrun during the freezing process. Incorporating too much air dilutes the structural solids-not-fat and fat content, yielding a weak matrix that feels empty and lacks desirable creamy density.

44. (C) Khoa
Khoa is a traditional Indian deseeded dairy product evaluated for its characteristic slightly granular body and pleasant caramelized flavor. These sensory properties develop during the continuous thermal concentration of milk in an open pan, which promotes protein denaturation, lactose crystallization, and non-enzymatic Maillard browning reactions, defining the quality and grade of the final product.

45. (D) A is false but R is true.
Chhana intended for premium Rasogolla manufacture should not have a hard and firm texture, as this prevents the product from expanding and absorbing sugar syrup during cooking. Instead, a soft, smooth, and cohesive body is required. A hard texture lacks the necessary elasticity and water-binding capacity, which indeed prevents the formation of spongy, smooth sweets.

46. (C) Contamination with yeasts producing ethanol and gassy off-flavor development
A yeasty flavor in fermented dairy products like Dahi is a severe quality defect indicating microbial contamination with wild yeasts. These contaminants ferment lactose and residual sugars, producing ethanol and carbon dioxide gas. This activity leads to a sharp, fizzy off-flavor, an undesirable yeasty aroma, and a bubbly, disturbed curd structure, indicating poor plant hygiene.

NODIA

47. (B) Wettability index
The wettability index is a physical measurement used to evaluate the reconstitution properties of milk powder. It measures the ability of a powder to absorb water on its surface and sink, which is a critical preliminary step in dissolution. Poor wettability leads to clumping and slow, incomplete reconstitution, which negatively affects the user's sensory experience.

48. (D) Objective methods use instruments; subjective methods rely on human perception.
The fundamental difference between evaluation methods lies in the measurement source. Objective methods utilize analytical instruments,

(A) Pure, concentrated ethanol vapor
(B) Highly concentrated lactic acid
(C) Filtered air or pure nitrogen gas
(D) Purified and concentrated ozone

2024
201. Which off-flavor in liquid milk is most definitively characterized by a cardboard-like or metallic taste?
(A) Malty
(B) Lipolyzed
(C) Putrid
(D) Oxidized

2024
202. A sticky body in butter is often a consequence of:
(A) Cattle feeding on winter grass, raising high-melting fats
(B) Incorporating excessive air volume during butter churning
(C) Operating at extremely low mechanical speeds when churning
(D) Adding excessive amounts of natural yellow annatto color

2003
203. Which objective parameter is critical for evaluating the baking performance of Mozzarella cheese on a pizza?
(A) Bitterness intensity profiles
(B) Meltability and stretchability
(C) Whey syneresis and leakage rate
(D) Eye formation density and size

2002
204. "Sandiness" in ice cream is an irreversible textural defect that occurs when lactose crystals grow beyond approximately what size?
(A) 2-5 micrometers
(B) 15-25 micrometers
(C) 50-70 micrometers
(D) 1-2 millimeters

2004
205. The primary sensory difference between Khoa and Peda is that Peda contains:
(A) Sugar and flavorings, shaped into pieces
(B) Added salt and spices, processed as paste
(C) Significantly lower amounts of total solids
(D) Higher levels of free, unbound moisture

2012
206. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): High-quality Paneer should possess a compact, firm, and cohesive body.
Reason (R): Subjecting the hot coagulum to mechanical pressing expels excess whey and forms a closely knit casein matrix.
In the light of the above statements, choose the correct answer from the options given below:
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2023
207. A "wheyey" or "watery" flavor in Shrikhand is considered a defect and is usually the result of:
(A) Excessive addition of sugar crystals
(B) Using high-fat buffalo milk source
(C) Adding too much ground cardamom seed
(D) Incomplete drainage of chakka whey

2022
208. The insolubility index of milk powder is an objective sensory-related metric indicating:
(A) The degree of surface fat oxidation during storage
(B) The total amount of free amorphous lactose available
(C) Protein denaturation causing incomplete dissolution
(D) The color degradation and browning of the powder

2008
209. Organoleptic evaluation involves the assessment of food using:
(A) Only the primary sense of taste
(B) All five of the fundamental human senses
(C) Exclusively instrumental rheological tests
(D) Historical consumer purchasing databases

NODIA

2002
210. Which primary taste bud papillae do not contain taste receptors and function only to provide friction on the tongue surface?
(A) Fungiform
(B) Circumvallate
(C) Foliate
(D) Filiform

2024
211. The detection of a volatile food compound originating from the mouth and moving up into the nasal cavity during swallowing is called:
(A) Retro-nasal olfaction

19. (A) Lactose
Sandiness in ice cream is a severe textural defect caused by the formation of large lactose crystals. Since lactose has relatively low solubility, temperature fluctuations during storage cause it to crystallize out of solution. When these crystals exceed a certain size, they are perceived by the tongue as coarse, gritty particles, ruining the smooth mouthfeel.

20. (D) Maillard reaction
During the production of Khoa, milk is concentrated by continuous heating, which promotes the Maillard reaction. This non-enzymatic browning occurs between the carbonyl groups of lactose and the amino groups of milk proteins, particularly lysine. Excessive browning indicates overheating, leading to dark colors, caramelized off-flavors, and a loss of nutritional quality in the final product.

21. (B) Soft and cohesive
High-quality Paneer must possess a soft, cohesive, and compact body that holds its shape during slicing and cooking. It should not be excessively hard, rubbery, dry, or crumbly, which indicates low moisture or improper coagulation parameters. A soft and cohesive texture ensures a desirable mouthfeel and optimum performance in traditional culinary preparations.

22. (C) The separation of whey from the curd matrix
Syneresis is a common physical defect in fermented milks like yoghurt, characterized by the spontaneous separation and accumulation of whey on the product surface. This occurs when the protein gel network weakens and shrinks, losing its water-holding capacity. Factors contributing to syneresis include low total solids, excessive acidity, or mechanical disturbance during gel formation.

23. (D) Caking
Storage of milk powder in high humidity environments leads to moisture absorption, which increases the molecular mobility of lactose. This causes amorphous lactose to transition into crystalline hydrate form, releasing bound moisture and causing the powder particles to stick together. This physical defect, known as caking, severely impairs solubility and flowability.

24. (A) I and III
Fechner's Law states that subjective sensation is proportional to the logarithm of stimulus intensity, assuming all just noticeable differences are subjectively equal. Weber's Law states that the ratio of the increment threshold to background intensity is constant. However, Stevens' Power Law, using an exponential function, is widely considered more accurate than Fechner's Law.

25. (B) Adaptation
Adaptation is the temporary decrease in olfactory or gustatory sensitivity to a specific stimulus resulting from continuous, prolonged exposure to that substance. This physiological fatigue occurs at the receptor level, preventing overload and allowing the sensory system to remain sensitive to new changes. To avoid adaptation, panelists must rinse their mouths or rest between samples.

26. (B) Olfactory mucosa
The olfactory mucosa is a specialized tissue lining the nasal cavity that contains the olfactory epithelium and a protective mucus layer. This mucus dissolves inhaled volatile odorant molecules, allowing them to bind to the cilia of olfactory sensory neurons. This dissolution is a crucial preliminary step for triggering sensory signals in the olfactory system.

27. (A) Somatosensory and pain receptors
Chemesthesis refers to chemically induced sensations that arise when chemical compounds activate somatosensory, thermal, or nociceptive receptors in the oral or nasal cavities. Unlike classical gustation, which relies on taste buds, chemesthesis involves the trigeminal nerve system. It mediates sensations such as the heat of capsaicin, cooling of menthol, and carbonation tingling.

28. (C) $S = kI^n$
Stevens' Power Law describes the relationship between subjective sensation magnitude and physical stimulus intensity using a power function. The exponent in this formula is unique to each sensory modality, determining whether sensation grows rapidly or saturates. This law offers a highly versatile mathematical model, widely accepted as superior to logarithmic models across extreme ranges.

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2001

221. Which descriptive analysis method uses a specialized, proprietary language and evaluates the "amplitude" of a product's overall flavor?
(A) Flavour Profile Method
(B) Quantitative Descriptive Analysis
(C) Spectrum Method
(D) Free Choice Profiling

2011

222. In TDS (Temporal Dominance of Sensations) analysis, a sensation is considered "dominant" if it is:
(A) The mathematically most intense sensory stimulus
(B) The only chemical compound present in the mouth
(C) The sensation capturing most attention at that moment
(D) The final sensation perceived before product swallowing

2007

223. What does an Electronic Tongue (E-tongue) output primarily consist of?
(A) Exact concentrations of individual sugars and acids
(B) Total counts of viable lactic acid bacteria present
(C) The precise prediction of shelf-life in actual days
(D) A signal matrix representing global taste profiles

2002

224. Which dairy off-flavor is characterized by the degradation of amino acids into compounds like 3-methylbutanal due to bacterial action?
(A) Oxidized
(B) Rancid
(C) Malty
(D) Light-activated

2023

225. A crumbly texture in butter indicates a lack of:
(A) Hardness
(B) Cohesiveness
(C) Adhesiveness
(D) Fracturability

2025

226. Cheddar cheese that lacks sufficient acid development during manufacture will likely present with which flavor profile?
(A) Excessively sharp, sour, and biting
(B) Intensely bitter and soapy on palate
(C) Highly fruity, yeasty, and fermented
(D) Flat, bland, and lacking sharpness

2015

227. An "icy" defect in ice cream evaluates poorly on the sensory scorecard and is predominantly a failure of:
(A) Mix formulation and storage temperature control
(B) Emulsifier and stabilizer blending uniformities
(C) Liquid flavoring extract and color paste additions
(D) Secondary cardboard and plastic packaging designs

2007

228. A desirable characteristic of high-quality Khoa is a slightly sweet, rich cooked flavor. If the product tastes sour, it most likely indicates:
(A) Excessive crystallization and addition of white sugar
(B) Utilizing over-neutralized raw milk processing runs
(C) Use of high-acid milk prior to heat desiccation
(D) Introducing excessive ground cardamom seed flavoring

NODIA

2004

229. Which defect in Paneer relates to a lack of proper shape retention and structural integrity when cut?
(A) Loose and crumbly
(B) Hard and rubbery
(C) Spongy and porous
(D) Chewy and sticky

2025

230. During the sensory grading of Yoghurt, a "yeasty" or "fruity" flavor is heavily penalized because it indicates:
(A) Optimal fermentation by Lactobacillus bulgaricus
(B) High fat content masking the acid
(C) The natural breakdown of milk proteins
(D) Contamination by undesirable yeasts or molds

****

(B) Ortho-nasal olfaction
(C) Chemesthesis
(D) Trigeminal stimulation

2006

212. Match the sensory tests in List I with their corresponding defining objectives in List II:

List I: (Discriminative Sensory Test)

P. Triangle test
Q. Paired-comparison test
R. Ranking test
S. Duo-trio test

List II: (Defining Objective)

1. Identifies which of two coded samples matches a reference
2. Identifies the single odd sample among three
3. Compares two samples for a specific attribute intensity
4. Orders multiple samples based on intensity or preference

(A) P-1, Q-4, R-3, S-2
(B) P-3, Q-2, R-1, S-4
(C) P-2, Q-3, R-4, S-1
(D) P-2, Q-1, R-4, S-3

2015

213. Weber's Law implies that as the background intensity of a sensory stimulus increases, the minimum change required to notice a difference:
(A) Increases proportionally
(B) Decreases proportionally
(C) Remains completely constant
(D) Becomes undetectable

2007

214. What occurs when a panelist repeatedly evaluates highly sweet samples and subsequently perceives a mildly sweet sample as completely unsweetened?
(A) Sensory synergy
(B) Acid enhancement
(C) Halo effect bias
(D) Sensory adaptation

2004

215. Which secondary mechanical parameter is derived from TPA by calculating (Hardness $\times$ Cohesiveness)?
(A) Springiness
(B) Gumminess
(C) Chewiness
(D) Fracturability

2023

216. To prevent order bias and carry-over effects in sensory evaluations, the presentation sequence of samples should be:
(A) Identical for all panelists
(B) Always from weakest to strongest concentration
(C) Balanced and randomized
(D) Alphabetical based on sample codes

2025

217. When establishing a trained descriptive panel, the standard recommended minimum number of panelists is typically:
(A) 2 to 3
(B) 5 to 6
(C) 10 to 12
(D) 50 to 100

2016

218. The "stimulus error" occurs when a panelist's judgment is influenced by:
(A) Physical presentation properties like cup size or color
(B) Personal levels of physiological hunger or satiety
(C) Verbal communication and feedback of other panelists
(D) Specific times of the day the test session is run

2002

219. The two-out-of-five test is highly efficient statistically but is generally avoided for dairy products with strong lingering flavors because:
(A) It requires an excessively massive sample volume
(B) Sensory fatigue occurs rapidly over five samples
(C) It is limited to evaluating color differences
(D) The necessary statistical tables do not exist

2008

220. The 9-point Hedonic scale is considered a balanced scale because it contains:
(A) Nine completely distinct and descriptive categories
(B) Equal positive and negative levels around a midpoint
(C) Continuous qualitative anchors without any numbers
(D) Only positive acceptance and preference categories

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This test identifies individuals with normal taste sensitivity and screens out those with taste deficiencies. Establishing basic taste acuity is essential before selecting individuals for advanced descriptive sensory panels.

10. (B) Halo effect
The halo effect occurs when a panelist's positive or negative impression of a single attribute influences their evaluation of other unrelated characteristics. For instance, an appealing aroma might cause an assessor to rate the flavor or texture of a dairy product more highly. Training helps panelists isolate individual attributes, reducing this common psychological source of error.

11. (A) Duo-trio test
The duo-trio test is a discriminative sensory method where panelists receive a labeled reference sample followed by two coded samples. One coded sample matches the reference, while the other is different. Panelists must identify which coded sample is identical to the reference, resulting in a fifty percent probability of obtaining the correct answer by chance.

12. (B) P-2, Q-4, R-3, S-1
Sensory evaluation utilizes distinct scaling techniques to measure human perception. The nine-point hedonic scale measures the degree of liking from extreme dislike to extreme like. Continuous line scales allow panelists to mark perceived intensity, which can be unstructured without intermediate marks. Structured scoring uses discrete numerical intervals, providing standardized frameworks for evaluating food quality attributes.

13. (D) Flavour Profile Method
The Flavour Profile Method is a qualitative and quantitative descriptive technique relying on a highly trained panel to reach a consensus regarding the overall flavor system. Panelists work together to define individual flavor attributes, their order of appearance, intensity, aftertaste, and total amplitude. This consensus approach distinguishes it from other independent descriptive analysis methods.

14. (C) The sensory attribute perceived as dominant at any given moment
The Temporal Dominance of Sensations method is a multi-attribute temporal sensory technique that tracks the shifting dominance of specific sensations during consumption. Panelists are presented with a list of attributes and select which one is dominant at any given moment. This provides a dynamic profile of how product characteristics change continuously throughout mastication and swallowing.

15. (A) Both A and R are true and R is the correct explanation of A.
The electronic nose mimics human olfaction using non-specific, cross-reactive chemical sensor arrays that interact with headspace volatiles. Rather than identifying individual compounds as a chromatograph does, the system generates a complex response pattern. Consequently, comprehensive prior training with known standards is necessary to establish reference patterns for classifying and identifying complex dairy aromas during analysis.

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16. (D) Light-activated
Exposure of liquid milk to light triggers the degradation of riboflavin, which acts as a photosensitizer. This process catalyzes the oxidation of lipids and proteins, particularly the amino acid methionine, to form methional, causing a characteristic light-activated off-flavor. This defect is distinct from typical auto-oxidation and requires protective packaging to prevent quality loss.

17. (A) Leakiness
Leakiness in butter is a physical defect characterized by the presence of large, visible water droplets exuding from the product surface during storage or cutting. This condition results from incomplete or improper working of the butter during manufacture, which fails to adequately disperse moisture into micro-droplets, compromising both appearance and microbiological stability.

18. (A) I and III
Bitter defects in Cheddar cheese occur when starter cultures release hydrophobic peptides during proteolysis without sufficient peptidase activity to break them down. Additionally, a corky body relates to low moisture content, making the cheese dry and crumbly. Late gas blowing is an undesirable defect caused by butyric acid bacteria, creating irregular holes and unpleasant off-flavors.

ANSWERS

1. (A) Organoleptic evaluation
Organoleptic evaluation relies entirely on the integrated physiological responses of human sensory organs, including sight, smell, taste, touch, and hearing, to assess food quality characteristics. Unlike instrumental methods that provide objective physical or chemical data, this approach measures subjective human perception, making it crucial for determining consumer acceptability and product quality in the dairy industry.

2. (C) Filiform
Filiform papillae are the most abundant structures on the human tongue but do not contain taste buds. Their primary function is mechanical, providing a rough surface texture that assists in food manipulation and chewing. Conversely, fungiform, foliate, and circumvallate papillae house specialized gustatory receptors responsible for detecting basic taste modalities during consumption.

3. (A) The binding of odorants to matching olfactory receptors
The lock-and-key theory of olfaction proposes that volatile odorant molecules have specific three-dimensional shapes that fit into matching receptor sites on olfactory sensory neurons. This structural compatibility triggers a conformational change, generating neural signals transmitted to the brain. This mechanism explains how the olfactory system distinguishes thousands of distinct aroma compounds in complex food matrices.

4. (D) Pungency
Highly carbonated beverages stimulate the trigeminal nerve, which mediates somatosensory sensations such as chemical irritation, cooling, warming, and pungency. When carbon dioxide bubbles dissolve in saliva, they form carbonic acid, which excites nociceptors and tactile receptors. This response is separate from classic taste transduction, adding a unique physical, tingling dimension to sensory profiles.

5. (B) The initial intensity of the stimulus
Weber's Law states that the minimum change in stimulus intensity required to produce a noticeable difference is a constant ratio of the original stimulus magnitude. This means that as the baseline intensity increases, a larger physical increment is necessary for detection. This relationship helps food scientists understand how panelists perceive small differences in taste, aroma, or texture.

6. (C) Recognition threshold
The recognition threshold is the minimum concentration of a stimulus at which a panelist can correctly identify and describe the specific quality of the sensation, such as sweet or sour. It is higher than the detection threshold, where a stimulus is only perceived as different from water without its specific identity being recognized by the assessor.

7. (D) Primary parameter
In texture profile analysis, mechanical properties are classified into primary and secondary parameters. Cohesiveness is a primary parameter representing the strength of internal bonds making up the product body, resisting disintegration. Other primary parameters include hardness, viscosity, springiness, and adhesiveness, while secondary parameters like gumminess and chewiness are derived mathematically from these primary measurements.

8. (A) To mask visual color differences among samples
Red lighting is standard in sensory testing booths to eliminate bias caused by visual differences in sample color or appearance. By masking these differences, panelists cannot visually distinguish samples and must rely solely on taste, aroma, and texture. This control ensures independent, unbiased sensory evaluations of characteristics like flavor and mouthfeel.

9. (B) Basic taste acuity test
The basic taste acuity test is specifically designed to screen candidate panelists for their physiological ability to detect and recognize fundamental taste solutions at low concentrations.

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29. (D) Terminal threshold
The terminal threshold represents the maximum concentration of a physical stimulus beyond which any further increase in concentration fails to produce an increase in perceived sensation intensity. At this point, the sensory receptors are completely saturated with the stimulus. Consequently, higher concentrations cannot be differentiated, marking the upper limit of the sensory response curve.

30. (A) I, II and V
Standard sensory laboratory design guidelines require specific environmental controls to prevent bias. Relative humidity should be maintained at moderate levels, not eighty percent. Air systems must maintain positive pressure in the evaluation booths relative to the preparation kitchen to keep odors out. Furthermore, there must be no direct, unimpeded airflow between these two distinct areas.

31. (B) Hardness, cohesiveness, and springiness
In texture profile analysis, chewiness is a secondary parameter that characterizes the energy required to masticate a solid food product to a state ready for swallowing. It is mathematically defined as the product of three primary parameters: hardness, cohesiveness, and springiness. This derivative value provides a comprehensive objective index of food texture performance during consumption.

32. (D) Stimulus error
Stimulus error occurs when a panelist's evaluation of a product's sensory attributes is influenced by irrelevant external cues, such as premium packaging, brand names, or container materials. In this case, the panelist rates the product higher because they associate the high-quality packaging with superior taste, illustrating a cognitive bias that distorts objective sensory scoring.

33. (A) To determine product acceptability and preference
Untrained consumer panels represent the general public and are primarily used to evaluate product acceptability, preference, and liking. Unlike trained analytical panels, these assessors do not describe individual attributes or detect trace defects. Instead, their subjective feedback helps food manufacturers gauge market potential, consumer appeal, and overall satisfaction for new or modified dairy formulations.

34. (B) 33.3%
In a standard triangle test, panelists are presented with three coded samples, two of which are identical and one of which is different. The task is to identify the odd sample. Because there are three samples, a panelist guessing completely at random has a one-in-three chance, or approximately thirty-three point three percent probability, of choosing correctly.

35. (A) Term generation, Panel training, Product evaluation, Statistical analysis
Conducting a Quantitative Descriptive Analysis begins with term generation, where panelists develop descriptive words for the product attributes. This is followed by rigorous panel training to standardize anchor terms. Next, the actual product evaluation takes place under controlled sensory booth conditions, culminating in comprehensive statistical analysis of the descriptive data to map the sensory profile.

36. (D) Ranking test
The ranking test is a sensory evaluation method where panelists receive several coded samples simultaneously and must arrange them in a sequential order according to the perceived intensity of a specified attribute. This ordinal scaling approach is simple, rapid, and effective for comparing multiple samples, though it does not provide information on the absolute magnitude of differences.

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37. (B) The temporal onset, peak, and decay of sweetness
The Time-Intensity profiling technique is uniquely suited for measuring the temporal parameters of a single sensory attribute over time. It tracks key characteristics such as the speed of onset, maximum intensity reached, and the rate of decay as the product is consumed. This provides detailed insight into dynamic flavor release, particularly for sweetness or bitterness.

38. (C) Ion-selective potentiometric sensors
The electronic tongue mimics human taste perception in liquid samples using an array of ion-selective potentiometric or voltammetric sensors. These lipid membrane sensors interact with dissolved ionic species, generating electrical potential changes that correlate with different

2022
189. Thermal perception during the consumption of spicy foods is closely linked to which specific receptor family?
(A) Transient Receptor Potential (TRP) channels
(B) Gustducin-coupled sensory G-proteins
(C) Specialized voltage-gated sodium channels
(D) Tactile mechanoreceptors in oral tissue

2010
190. What is the fundamental premise of Stevens' Power Law?
(A) Sensation magnitude is equal to the logarithm of stimulus intensity.
(B) Sensory thresholds are identical across all human populations.
(C) Sensation magnitude is a power function of stimulus intensity.
(D) Visual stimuli always override gustatory stimuli.

2023
191. The threshold level below which a stimulus is completely undetectable by human senses is termed the:
(A) Terminal threshold
(B) Difference threshold
(C) Recognition threshold
(D) Absolute threshold

2004
192. Which primary texture parameter is defined subjectively as the force required to compress a substance between molar teeth?
(A) Fracturability
(B) Cohesiveness
(C) Hardness
(D) Adhesiveness

2012
193. Sensory testing booths are generally maintained under positive air pressure to:
(A) Accelerate the volatilization of food aromas
(B) Prevent odor ingress from preparation areas
(C) Increase the ambient oxygen level for panelists
(D) Maintain a lower internal room temperature

2004
194. Which type of sensory panel is typically composed of 10-15 members who undergo extensive product-specific training to precisely profile attributes?
(A) In-house consumer panel
(B) Untrained affective panel
(C) Expert grading panel
(D) Trained descriptive panel

2004
195. A panelist consistently scores samples toward the middle of the scale to avoid making extreme judgments. This is known as:
(A) Error of central tendency
(B) Error of habituation
(C) Contrast effect
(D) Pattern effect

2024
196. In a Duo-trio test, the panelist is presented with:
(A) Three coded test samples, where two are completely identical
(B) Two coded samples with the goal to identify which is sweeter
(C) A reference and two coded samples, one matching the reference
(D) Five fully coded samples to be grouped into two distinct sets

2024
197. Which of the following is an unstructured rating scale?
(A) 15-cm line scale with end anchors
(B) Standard 9-point Hedonic scale
(C) Structured 5-point category scale
(D) 100-point numerical score sheets

2011
198. The Quantitative Descriptive Analysis (QDA) methodology was originally developed by:
(A) Arthur D. Little
(B) Stevens and Fechner
(C) The International Dairy Federation
(D) Stone and Sidel

2003
199. Temporal Dominance of Sensations (TDS) differs from Time-Intensity (TI) because TDS:
(A) Measures the absolute intensity of a single sensory attribute
(B) Identifies the dominant attribute over time from a given list
(C) Can only be applied to solid and highly structured food matrices
(D) Does not require computerized software systems for data collection

2013
200. Electronic Nose sensors undergo a baseline calibration before analyzing a sample headspace. This is usually achieved by purging the sensors with:

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such as texture analyzers, colorimeters, or gas chromatographs, to measure physical, chemical, or rheological properties directly. Subjective methods, conversely, rely entirely on human sensory perception, using panels to evaluate taste, aroma, texture, and consumer acceptance characteristics.

49. (A) L-glutamate
The umami taste sensation, often described as savory or meaty, is primarily triggered by the binding of L-glutamate to G-protein coupled receptors on taste cells. This amino acid is found naturally in aged cheeses and protein-rich dairy products. Its perception is enhanced synergistically by purine nucleotides like inosine monophosphate, creating a rich, complex taste profile.

50. (A) P-3, Q-1, R-4, S-2
Tactile and somatosensory sensations contribute significantly to food perception. Astringency is triggered by tannins or acidic whey proteins, which precipitate salivary proteins. Cooling is stimulated by compounds like menthol that trigger cold receptors. Pungency arises from chemical irritants like capsaicin, while viscosity measures resistance to flow, which increases with the addition of stabilizers and gums.

51. (A) Volatiles travel from the oral cavity to the nasopharynx during mastication.
Retro-nasal olfaction occurs when volatile compounds released from food during mastication and swallowing travel from the oral cavity up through the nasopharynx to the olfactory epithelium. This pathway is responsible for the overall perception of flavor, blending taste and smell, unlike ortho-nasal olfaction, which detects external aromas directly inhaled through the nostrils.

52. (D) Cold temperatures suppress aroma volatility and numb taste receptors.
The low temperature of ice cream directly affects flavor release and perception. Extreme cold suppresses the volatility of aroma compounds, reducing the amount of volatile molecules reaching the olfactory receptors via the retro-nasal route. Additionally, cold temperatures temporarily numb the gustatory receptors on the tongue, diminishing the perceived intensity of sweetness and other basic tastes.

53. (B) Difference threshold
The difference threshold, also referred to as the just noticeable difference, is the smallest physical increment in stimulus intensity required to produce a perceptible change in sensation. It is not a fixed value but varies depending on the initial intensity of the stimulus, as modeled by Weber's Law, representing a fundamental limit of sensory discrimination.

54. (C) Overcome attractive forces between the food surface and the mouth.
In rheological and sensory terms, adhesiveness is defined as the work required to overcome the attractive forces between the surface of a food product and the contact surfaces of the mouth, teeth, or palate. It indicates how sticky a semi-solid food is, influencing how long the sample remains adhered to oral tissues during chewing.

55. (D) I and II
Sensory evaluation laboratories must maintain controlled climate conditions. Air handling systems with activated carbon filters are mandatory to eliminate background odors that interfere with assessments. The ambient temperature is ideally kept between twenty and twenty-two degrees Celsius. However, relative humidity should be maintained at a comfortable fifty percent, not above ninety percent.

56. (C) A is true but R is false.
Expert sensory panels consist of highly trained individuals selected for their high sensory acuity and reproducibility in detecting subtle product attributes. While their performance is indeed highly controlled, they are not used to determine broad consumer liking or market acceptance. Such hedonic questions are reserved for large, untrained consumer panels representing the target market.

57. (B) Psychological bias
Psychological biases, such as expectation error, halo effects, and contrast errors, can systematically distort sensory data. These biases are minimized by conducting rigorous panelist training, providing standard reference samples, and randomizing the presentation order of samples. These controls prevent panelists from guessing or letting external factors influence their objective ratings.

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compounds, while sourness alerts organisms to spoilage, microbial fermentation, or unripe food sources containing high acid concentrations.

119. (B) Detects odorants inhaled through the nostrils
Olfactory perception occurs through two distinct pathways depending on the direction of airflow. Ortho-nasal olfaction involves inhaling external volatile compounds directly through the nostrils, allowing initial aroma detection before food enters the mouth. This contrasts with retro-nasal olfaction, where volatile molecules travel from the oral cavity to the olfactory epithelium during mastication and swallowing.

120. (C) Trigeminal nerve
Somatosensory inputs, which include tactile, thermal, and chemical irritation sensations within the mouth, are mediated by cranial nerves. The trigeminal nerve is primarily responsible for transmitting these mechanical and chemesthetic signals from the oral cavity to the brain. This pathway allows consumers to perceive food attributes like temperature, creaminess, carbonation, and chemical heat or cooling.

121. (D) Response compression (sensation grows slower than stimulus)
Stevens' Power Law models the mathematical relationship between physical stimulus intensity and perceived sensory magnitude. When the exponent in this power function is less than one, it represents response compression. In this state, equal percentage increases in physical stimulus intensity yield progressively smaller increases in perceived sensation, which is typical for modalities like brightness and odor.

122. (A) Increases as the background stimulus intensity increases
The difference threshold, also referred to as the just noticeable difference, is not a fixed physical value. According to psychophysical principles, this threshold increases as the background intensity of the stimulus increases. This means that at higher baseline concentrations or physical intensities, a larger absolute change is required for a person to detect a difference.

123. (B) Springiness
Springiness is a key textural parameter evaluated during instrumental and sensory analysis of foods. It measures the physical rate and extent to which a deformed material returns to its original shape and height after the initial compressing force has been removed. This property is crucial for assessing elastic qualities in products such as cheese or gelatins.

124. (A) II, III and IV
Proper design of a sensory laboratory ensures objective, unbiased results. A pass-through hatch prevents direct interaction between panels and operators, which controls bias. Adjustable lighting, including colored lights, allows operators to mask visual differences among samples. Additionally, positive air pressure keeps the testing environment free from external odors, whereas highly saturated wall colors are discouraged due to distraction.

125. (A) Detect and recognize basic tastes and odors at low concentrations
Sensory acuity screening is a critical step when selecting and training members for a descriptive panel. This specific test assesses an individual's biological capacity to identify, distinguish, and describe basic tastes and common food odors at low concentrations. Ensuring panelist sensitivity prevents the inclusion of individuals with taste blindness or olfactory deficiencies in subsequent analytical testing.

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126. (C) Evaluating only one attribute per session or separating questions sequentially
The halo effect is a psychological bias where a panelist's overall positive or negative impression of a sample influences their evaluation of individual, unrelated attributes. To prevent this bias, sensory protocols recommend evaluating only one attribute per session or presenting questions sequentially. This physical separation prevents one dominant characteristic from skewing ratings of other product attributes.

127. (D) Triangle test
When detecting subtle differences resulting from product reformulation, select discriminative tests that offer high statistical power. The triangle test is widely preferred in such cases. Panelists are presented with three samples, where two are identical and one is different. Because the probability of guessing the correct sample by chance is low, it yields superior statistical reliability.

68. (A) II and III
In Chhana evaluation, a soft and smooth body is a highly desirable textural attribute, not a defect, as it ensures a high-quality finished sweet. Excessive moisture content is also undesirable, as it promotes microbiological spoilage and decreases shelf life. However, a sour flavor is indeed a defect, indicating delayed coagulation or improper cooling.

69. (B) Casein gel network stability
Assessing syneresis in set yoghurt is a direct measure of the stability of the casein gel network. A weak or disrupted protein matrix cannot hold water effectively, leading to the expulsion of whey. Evaluating syneresis helps manufacturers adjust milk solids, starter culture activity, or stabilizer levels to ensure a stable, appealing product with minimal free liquid.

70. (C) Initial bite hardness, Cohesiveness during chewing, Flavor release, Residual mouthfeel
The physiological process of eating a firm cheese proceeds through a logical chronological sequence. First, the consumer perceives the initial bite hardness as the teeth compress the sample. During mastication, they perceive cohesiveness and breakdown. This structural breakdown promotes the release of flavor and volatile compounds, culminating in the perception of a lingering residual mouthfeel.

71. (D) Oxidized flavor
A stale flavor in milk powder is an early sensory warning sign of lipid deterioration, which often serves as a precursor to a more severe oxidized defect. This occurs during extended storage as unsaturated fatty acids interact with oxygen, forming volatile aldehydes and ketones. This reaction eventually develops into a distinct cardboard-like, metallic, or painty off-flavor.

72. (A) Latin square design
The Latin square design is a balanced sensory presentation method used to eliminate order and carry-over biases. By ensuring that every sample appears in each presentation position an equal number of times across all panelists, this design controls for sequential contrast effects. This statistical balancing is crucial for obtaining unbiased, reliable sensory scores in comparative testing.

73. (B) Circumvallate papillae
Circumvallate papillae are large, V-shaped structures located at the very back of the tongue. Although they are few in number, they house the largest concentration of individual taste buds on the human tongue. Their strategic position allows them to perform a final gustatory check on food and beverages immediately before the bolus is swallowed.

74. (B) I, II and III
Basic tastes utilize distinct physiological transduction mechanisms. Saltiness is triggered by sodium ions entering specific ion channels, depolarizing the cell. Sourness involves hydrogen ions blocking potassium channels or entering proton channels. Sweetness is mediated by G-protein coupled receptors. However, bitterness also utilizes G-protein coupled receptors, rather than exclusively relying on ion channel blockades.

75. (D) A is false but R is true.
The perception of astringency is a tactile sensation that does not develop immediately or dissipate rapidly upon expectoration. It is caused by the precipitation of lubricating salivary proteins by compounds like tannins or whey proteins in acidic environments. This loss of lubrication increases friction between the tongue and palate, creating a characteristic puckering sensation.

76. (C) Stevens' Power Law
Stevens' Power Law is highly accurate for describing sensory magnitude because it uses an exponent unique to each sensory modality. This exponent dictates how perceived intensity scales with physical stimulus concentration, making the law highly versatile across extreme ranges. It accommodates both compression, like brightness, and expansion, like electric shock, far better than logarithmic models.

77. (D) The saturation point beyond which increased intensity is unperceived
The terminal threshold is the concentration of a stimulus beyond which no further increase in intensity can be subjectively perceived. At this level of physical concentration, the sensory receptor cells are completely saturated. Consequently, adding more of the stimulus will not alter the panelist's sensation, defining the upper limit of the physiological response curve.

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58. (A) 50.0%
The duo-trio test is a forced-choice discriminative method where a panelist is presented with a reference sample and two coded test samples, one of which is identical to the reference. Because there are only two choices for the match, the mathematical probability of a panelist selecting the correct sample purely by chance is exactly fifty percent.

59. (A) Dislike extremely to Like extremely
The standard nine-point hedonic scale is an affective scaling method widely used to measure consumer preference and acceptability. The scale ranges from dislike extremely at point one, through a neutral point five of neither like nor dislike, to like extremely at point nine. This structure provides a balanced, reliable tool for quantifying subjective product liking.

60. (A) I and IV
The Texture Profile Method is an analytical descriptive sensory technique, meaning it requires highly trained panels rather than untrained consumers. It is used to systematically evaluate mechanical, geometrical, and moisture attributes of a wide range of foods, not just liquid milk, using structured scales anchored with reference standards to ensure high reproducibility and accuracy.

61. (D) Temporal Dominance of Sensations (TDS)
Temporal Dominance of Sensations is an advanced temporal technique that tracks the presence and shifting dominance of multiple sensory attributes throughout consumption. Panelists select which attribute is dominant at any given moment, rather than rating the intensity of a single attribute. This provides a multidimensional map of how product flavor and texture evolve in the mouth.

62. (A) P-4, Q-2, R-3, S-1
Instrumental sensory analogues correspond to human sensory modalities. Colorimeters measure light reflectance to emulate human vision. Texture analyzers apply mechanical forces to simulate somatosensory properties. Electronic noses utilize gas sensors to mimic olfactory detection of volatile compounds, and electronic tongues employ liquid sensor arrays to simulate gustatory pathways, providing objective data that correlates with human perception.

63. (B) Free fatty acids
Lipolyzed or rancid off-flavors in milk are caused by the hydrolysis of milk fat, which releases short-chain free fatty acids. This enzymatic breakdown is mediated by lipases, which are either native to milk or produced by psychrotrophic bacterial contaminants. The accumulation of these acids imparts a sharp, soapy, and pungent flavor to the dairy product.

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64. (D) Appearance defect
Mottling in butter is classified as an appearance defect, characterized by an uneven distribution of color resulting in dark and light patches on the butter surface. This is caused by improper working of the butter, which fails to distribute salt uniformly, leading to localized water absorption and localized color variations that compromise the visual quality.

65. (B) I and IV
High-quality Mozzarella cheese is characterized by excellent stretchability upon heating and a mild, slightly acidic, and milky flavor profile. A crumbly texture or excessive eye-formation are highly undesirable defects in Mozzarella, which should be smooth, fibrous, and cohesive. Furthermore, while moderate oiling-off is expected, excessive oil release during baking is considered a defect.

66. (C) Protein destabilization
A curdy appearance during the meltdown evaluation of ice cream indicates protein destabilization. If the milk proteins, particularly caseins, are destabilized due to high acidity, calcium imbalance, or poor stabilization, they coagulate during melting. This prevents the ice cream from melting into a smooth, creamy liquid, instead yielding an unappealing, curdled, whey-like residue.

67. (A) Mildly caramelized flavor with a cohesive body
A high-quality traditional Peda is characterized by a mildly caramelized, sweet flavor and a cohesive, smooth, or slightly granular body. It should not exhibit a salty flavor, a pale white color, or a spongy, elastic texture, which indicate processing errors. The desirable sensory characteristics develop through the controlled heat concentration of milk solids and sugar.

88. (A) Adheres to the palate and utensils
A sticky defect in butter refers to a textural property where the product adheres excessively to the palate, teeth, or utensils during cutting, spreading, or eating. This is caused by improper fat crystallization or working, which results in a high proportion of liquid fat that increases the attractive forces between the butter and contacting surfaces.

89. (B) Emmental
Emmental is correct because its characteristic round eyes are formed by carbon dioxide produced during fermentation by Propionibacterium freudenreichii. The size, number, and distribution of these eyes are important grading criteria that indicate proper ripening and quality. Cheddar does not normally develop eyes, while Mozzarella and Cream Cheese are evaluated mainly for texture, moisture, and flavor rather than eye formation.

90. (A) I and II
Iciness in ice cream is a defect caused by the formation of large ice crystals due to temperature fluctuations, while a gummy body indicates the excessive use of stabilizers. Excellent meltdown, however, means the ice cream melts into a smooth, liquid state, not retaining its solid shape. Fluffiness is a defect, making statement four incorrect.

91. (A) Diacetyl
Diacetyl is the volatile flavor compound primarily responsible for the characteristic, rich, buttery aroma of high-quality Ghee and butter. This dicarbonyl compound is produced during the fermentation of milk by lactic acid bacteria or developed during the clarification process of butterfat, playing a critical role in the sensory acceptance of traditional dairy products.

92. (A) I, III, II, IV
Conducting an objective Texture Profile Analysis begins with positioning the standardized food sample on the testing platform. Next, the instrument compresses the sample with a probe twice in a two-bite test. This compression generates a force-time deformation curve, which is finally analyzed to calculate parameters like hardness, springiness, and cohesiveness.

93. (D) Lactic acid
Over-sourness in yoghurt is caused by the continued metabolic activity of starter cultures, particularly Lactobacillus delbrueckii subsp. bulgaricus, which ferment lactose into lactic acid. This post-acidification occurs when yoghurt is not cooled rapidly after fermentation or is stored at elevated temperatures, leading to an excessively sharp, acidic taste profile.

94. (C) Caking
The reconstitution properties of milk powder are severely compromised when the product undergoes caking. This physical defect occurs when moisture absorption causes amorphous lactose to crystallize, binding the powder particles into hard lumps. This structural change prevents the powder from dispersing and dissolving easily in water, leading to clumping and poor reconstitution performance.

95. (A) I, III and IV
Subjective methods measure consumer acceptance and require standardized, controlled environments to minimize bias, while objective methods directly measure physical, chemical, or rheological properties using calibrated instruments. Instrumental readings should not rely on the operator's physiological state. Furthermore, these two approaches are not mutually exclusive and often show strong, useful correlations in food research.

96. (D) Facial (VII), Glossopharyngeal (IX), and Vagus (X)
Gustatory signals from the taste buds are transmitted to the brain via three specific cranial nerves. The facial nerve (VII) innervates the anterior two-thirds of the tongue, the glossopharyngeal nerve (IX) carries signals from the posterior third, and the vagus nerve (X) transmits signals from the epiglottis and pharynx, ensuring comprehensive taste transduction.

97. (B) G-protein coupled receptors (GPCRs)
G-protein coupled receptors act as the primary membrane receptors for sweet, bitter, and umami taste sensations. When a taste molecule binds to these specialized receptors, it initiates an intracellular signaling cascade involving secondary messengers, which ultimately depolarizes the taste cell and triggers a neural signal to the brain, unlike the ion channels used for salt and sour.

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138. (A) Body and texture/appearance
Wheying off, or syneresis, refers to the undesirable separation and accumulation of whey on the surface of set dahi. In sensory grading, this phenomenon is evaluated as a physical defect under the body, texture, and appearance categories. It indicates a weak gel structure unable to retain water, which diminishes the visual appeal of the product.

139. (B) Strong caramelized flavor and darker color
Evaporated milk undergoes rigorous thermal sterilization to ensure commercial shelf stability. When exposed to excessive heat treatment during this stage, the chemical interaction between milk proteins and lactose is accelerated. This Maillard reaction produces a strong caramelized flavor profile and a distinct darkening of the product color, which are graded as sensory defects.

140. (B) P-3, Q-1, R-2, S-4
Subjective sensory terms used by panel members can be mapped to objective rheological parameters. In food physics, thickness corresponds directly to viscosity, which measures flow resistance. Firmness maps to hardness, representing the force required to compress the sample. Bounciness reflects springiness, while stickiness represents adhesiveness, indicating the force needed to peel the sample from a surface.

141. (A) Insula and frontal operculum
Neural processing of taste begins on the tongue and is transmitted via cranial nerves to the brain. The primary gustatory cortex, which is responsible for the conscious perception and identification of basic tastes, is anatomically located within the insula and the adjacent frontal operculum. This region decodes the quality and intensity of gustatory stimuli.

142. (C) Retro-nasal pathways are influenced by mastication, temperature, and saliva
Ortho-nasal and retro-nasal olfaction deliver different flavor perceptions due to physical conditions during consumption. Retro-nasal olfaction occurs while eating, where food undergoes mastication, warming to body temperature, and mixing with saliva. These physiological processes release and alter volatile compounds, transferring them to the olfactory epithelium from the back of the mouth, changing the perceived intensity.

143. (D) Mild trigeminal pungency or bite
Aged Cheddar cheese undergoes extensive proteolysis and lipolysis during ripening, leading to the accumulation of various compounds. Among these, certain short-chain fatty acids, free amino acids, and amines stimulate trigeminal nerve endings in the oral cavity. This interaction produces a mild trigeminal pungency or bite, which is highly characteristic of well-matured varieties.

144. (C) The Weber fraction representing a constant
Weber's Law is a fundamental principle in psychophysics that describes the relationship between physical stimuli and human perception. In the formula, K represents the Weber fraction. This fraction is a constant value indicating that the ratio of the difference threshold to the background stimulus intensity remains constant across the middle range of sensory modalities.

145. (B) Higher than or equal to the detection threshold
In psychophysics, different levels of sensory thresholds are defined based on human detection capacity. The detection threshold represents the lowest concentration of a stimulus where its presence is noticed, without identifying what it is. The recognition threshold is the level where the stimulus is correctly identified, which is always higher than or equal to detection.

146. (D) Viscoelasticity
Viscoelasticity is a fundamental rheological property exhibited by many complex food structures, including cheeses and high-fat dairy products. This behavior describes a material that simultaneously displays both solid-like elastic characteristics, such as recovering its original shape after deformation, and liquid-like viscous characteristics, which involve continuous, irreversible flow under applied stress over time.

147. (A) Monochromatic sodium vapor or colored red lighting
Designing a sensory analysis room requires minimizing visual distractions that could bias product assessments. International standards suggest using monochromatic sodium vapor lamps or colored red lighting. This specific illumination suppresses color differences among dairy samples, allowing panelists to focus exclusively on other attributes, such as texture, viscosity, odor, and flavor profiles.

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panelist during the evaluation period. This peak value is a critical metric for understanding flavor or texture dynamics, helping researchers determine the absolute strength of a sensory attribute as the product is consumed.

109. (D) Metal oxide semiconductor (MOS) sensors
The electronic nose system predominantly utilizes metal oxide semiconductor sensors to detect volatile organic compounds in the headspace of a sample. When volatile molecules adsorb onto the heated semiconductor surface, they alter its electrical conductivity. These conductivity changes are recorded as signals, which pattern recognition software translates into distinct aroma profiles.

110. (A) P-3, Q-1, R-4, S-2
Off-flavors in milk result from distinct chemical and physical changes. Oxidized flavors are catalyzed by copper or light, causing lipid auto-oxidation. Rancid flavors are caused by the lipase-mediated hydrolysis of milk fat. Malty flavors indicate bacterial contamination under poor cooling, while flat flavors are due to low total solids or the dilution of milk.

111. (B) Poor water droplet dispersion during working
Leakiness in butter is a physical defect that indicates poor water droplet dispersion during the working phase of manufacture. If working is incomplete, the moisture in the butter remains in large, visible droplets rather than being finely dispersed throughout the fat matrix. These droplets easily leak out, compromising the appearance and shelf life.

112. (D) Sour
A sour defect in Mozzarella cheese is often caused by using highly acidic raw milk or allowing excessive starter culture activity during processing. This leads to an overproduction of lactic acid, which imparts an uncharacteristically sharp, sour taste. This defect masks the desirable mild, milky flavor of fresh Mozzarella, reducing overall quality.

113. (A) Iciness
A coarse texture in ice cream is a physical defect characterized by a rough feel on the tongue. This condition is fundamentally a milder form of iciness, occurring when small ice crystals grow slightly larger during storage but have not yet reached the size associated with severe, gritty iciness. It indicates early temperature fluctuations.

114. (C) A whiter color and a more desirable granular texture
Buffalo milk is traditionally preferred over cow milk for Khoa manufacture because buffalo milk lacks beta-carotene, yielding a highly desirable, brilliant white product. Additionally, buffalo milk has larger fat globules and a different protein ratio, which contributes to a superior, slightly granular texture and excellent body in the finished Khoa.

115. (A) A firm block structure that can be sliced easily
Paneer evaluation differs from Chhana evaluation because Paneer must possess a firm, compact block structure that can be sliced easily without crumbling. Chhana, on the other hand, is a soft, cohesive, and granular curd used primarily as a base for making sweets. This structural difference requires distinct coagulation and pressing parameters during manufacture.

116. (C) Sweet-sour balance, distinct cardamom flavor, and a smooth, semi-solid body
Sensory evaluation of shrikhand focuses on key attributes that define its quality. A high-quality product displays a harmonious balance between sweetness and acidity, complemented by a characteristic cardamom aroma. The texture must be uniform, smooth, and semi-solid, without any graininess or liquid separation, which ensures a pleasant, cohesive mouthfeel during consumption.

117. (A) Viscosity and uniformity
Visvisually assessing evaporated milk involves rotating the container to observe how the product behaves. During the transfer process, the film of milk remaining on the glass walls serves as an indicator of physical properties. This visual check allows assessors to evaluate both the viscosity and the overall uniformity of the dairy emulsion without specialized instruments.

118. (C) I, II and III
Human taste modalities evolved as vital biological mechanisms to guide dietary choices and prevent ingestion of hazardous materials. Sweetness serves as an evolutionary reward signal for high-energy carbohydrates. Bitterness functions as a warning to avoid potentially toxic

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78. (C) The peak force generated during the first compression cycle
In texture profile analysis, hardness is defined as the peak force generated during the first compression cycle of the sample. This parameter represents the maximum resistance offered by the food material as it is deformed by the probe. It correlates closely with the initial force required to bite through a sample with the incisors.

79. (B) Noise and odor interference
Standard sensory laboratory design requires physical separation between the preparation area and the evaluation booths. This layout prevents cooking odors, preparation sounds, and clinking utensils from entering the booths and distracting the panelists. Eliminating these environmental interferences ensures that panelists can focus entirely on the samples, reducing external bias during testing.

80. (B) P-3, Q-4, R-1, S-2
Biases can significantly alter sensory data. Expectation error occurs when product information biases a panelist before tasting. Habituation describes diminished analytical attention due to repeating the same sample. Central tendency error is the tendency to avoid using the extreme ends of a scale, while synergy occurs when two components produce a sensation stronger than their sum.

81. (A) Two match type A, three match type B; probability is 10%
In a two-out-of-five test, the panelist is presented with five coded samples, containing two of one type and three of another. The task is to group the two matching samples together. Because of the large number of potential combinations, the mathematical probability of a panelist correctly grouping the samples purely by chance is exactly ten percent.

82. (C) Line scale (Unstructured)
The unstructured line scale relies on a panelist placing a mark on a horizontal line, typically fifteen centimeters long, which is anchored with descriptive intensity terms at each end. This continuous scaling method avoids the discrete intervals of structured scales, allowing panelists to express fine differences in perceived intensity without being constrained by pre-defined categories.

83. (A) Appearance order, intensity, aftertaste, and amplitude
The Flavour Profile Method evaluates flavor attributes based on their order of appearance, perceived intensity, aftertaste, and total amplitude, which is the overall balance and blend of the flavor system. This descriptive technique relies on a highly trained panel to reach a consensus, providing a detailed qualitative and quantitative picture of the product.

84. (D) Select the single dominant sensory attribute over time
Temporal Dominance of Sensations is a dynamic, multi-attribute sensory technique that requires panelists to continuously select which single attribute is dominant at any given moment during consumption. This approach focuses on the attribute that captures the most attention as the product breaks down, rather than measuring the absolute intensity of all attributes simultaneously.

85. (A) II
The electronic nose is designed to analyze the headspace volatiles of a sample, using non-specific, cross-reactive sensor arrays and pattern recognition software like Principal Component Analysis. It does not measure the exact molecular weight of individual odorants; that is the function of analytical instruments like mass spectrometers, making statement two incorrect.

86. (C) Smell the headspace, Take a small sip, Roll over the tongue, Expectorate/Swallow, Note aftertaste
The standard physiological sequence for evaluating milk flavor begins with smelling the cup's headspace to detect volatile aromas. The panelist then takes a small sip and rolls the liquid over the tongue to stimulate gustatory and tactile receptors. After swallowing or expectorating, they note any lingering aftertaste, ensuring a comprehensive sensory assessment.

87. (D) Growth of Lactococcus lactis var. maltigenes
A malty flavor in raw milk is a microbiological defect caused by the growth of Lactococcus lactis var. maltigenes. Under poor cooling conditions, this bacterium metabolizes leucine into 3-methylbutanal, which imparts a distinct cooked, malt-like off-flavor and odor. This defect indicates unsanitary milk handling and inadequate temperature control during storage.

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128. (A) Like moderately
The standard nine-point hedonic scale is a widely used tool in consumer sensory science to measure product acceptability. Each integer on the scale corresponds to a specific verbal anchor indicating the degree of liking. A score of nine represents liking extremely, while a score of seven represents liking moderately, which indicates a positive consumer response toward the tested product.

129. (B) Quantitative Descriptive Analysis
Quantitative Descriptive Analysis is a comprehensive sensory methodology used to profile products. This approach relies on a trained panel that collectively develops a standardized, clear vocabulary to describe product attributes. Panelists then evaluate the intensity of these attributes using unstructured line scales, providing quantitative data that can be analyzed using advanced statistical methods.

130. (A) II, I, IV, III
In time-intensity sensory evaluation, the chronological sequence of physiological events is critical for accurate data collection. First, the panelist introduces the sample into the oral cavity. Next, perceived sweetness increases until it reaches a maximum peak. The panelist then expectorates or swallows the sample, which initiates the final decay of sweetness intensity back to baseline.

131. (A) Sensor array
Electronic tongues are instrumental systems designed to mimic human taste perception. The primary operational component of this system is the sensor array, which contains lipid-membrane or electrochemical sensors. When immersed in a liquid food matrix, these sensors interact with dissolved taste compounds, generating electrical potential changes that represent the global chemical profile of the sample.

132. (C) Flavor
The American Dairy Science Association scorecard provides an objective framework for grading liquid milk quality. Because consumer acceptance is highly dependent on taste and aroma, this scorecard allocates the maximum number of points to the flavor category. Defects such as oxidation, rancidity, or weed flavors result in severe point deductions to maintain high quality standards.

133. (A) Mottling
Mottling is a distinct visual defect observed during the sensory grading of butter. It is characterized by an uneven, patchy distribution of color across the product surface. This defect is typically caused by improper moisture incorporation, incomplete working of the butter granules, or the uneven distribution of added salt during the manufacturing process.

134. (D) Excessively dry, hard, and lacking in cohesiveness
A corky texture in Cheddar cheese indicates a physical defect in body and texture. This condition is characterized by a product that is excessively dry, hard, and lacking in internal cohesiveness. When compressed, the cheese does not show normal elasticity or smooth breakdown, but instead breaks into coarse, crumbly, and wood-like particles.

135. (D) A is false but R is true.
Freshly drawn ice cream has a soft, semi-frozen state with unhardened structure, resulting in poor meltdown and shape retention at room temperature. The subsequent hardening process is essential because it freezes remaining water into a rigid ice crystal network. This process stabilizes the fat-protein matrix, which directly extends the meltdown time and improves product stability.

136. (C) Over-boiling and high sugar concentration
In peda manufacturing, the texture is highly dependent on boiling parameters and sugar levels. A sticky or chewy body is a defect that commonly arises from over-boiling the mixture and incorporating high sugar concentrations. These conditions increase the viscosity and promote sticky glass-like state transitions, making the finished product difficult to masticate during evaluation.

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137. (D) Casein micelle networks formed by heat and acid coagulation
Paneer achieves its characteristic elastic and chewy body through physical and chemical changes in milk proteins. When milk is heated and acidified, the protective kappa-casein is destabilized, causing the calcium-casein phosphate complex to precipitate. This forms a continuous, three-dimensional casein micelle network that traps moisture and fat, providing the required structural elasticity.

98. (C) Puckeriness and drying of oral surfaces
Astringency is a tactile sensation perceived as a feeling of puckeriness, roughness, and drying of the oral surfaces. It is caused by the precipitation of salivary proline-rich proteins by compounds like tannins or whey proteins in acidic environments. This loss of lubrication increases friction between the tongue and palate, creating a characteristic puckering sensation.

99. (A) Fechner's Law
Fechner's Law states that the subjective magnitude of a sensation is proportional to the logarithm of the physical stimulus intensity. This relationship assumes that all just noticeable differences represent subjectively equal steps in sensation. This logarithmic model explains how human senses compress wide ranges of physical energy into manageable, perceiveable intervals.

100. (A) III, IV, I, II
As the concentration of a stimulus increases from zero, the human sensory system experiences a specific chronological sequence of thresholds. First, the detection threshold is reached, where a stimulus is noticed. Next is the recognition threshold, where its identity is known. Then, the difference threshold is reached, and finally, the terminal threshold marks saturation.

101. (B) Cohesiveness
In texture profile analysis, cohesiveness is calculated as the ratio of the work done during the second compression cycle to the work done during the first compression cycle. This ratio measures how well the product withstands a second bite relative to its initial structural integrity, providing an objective index of internal bond strength.

102. (C) 40 dB
ISO guidelines for sensory testing facilities recommend keeping background noise levels in testing booths below forty decibels. Excess noise can distract panelists, increasing cognitive load and introducing experimental error. Maintaining a quiet, peaceful environment is essential for ensuring that assessors can focus entirely on the evaluation of sample appearance, flavor, and texture.

103. (D) Ranking test
The ranking test is a standard screening protocol used during panelist selection to evaluate a candidate's physiological ability to consistently order a series of basic taste solutions of varying concentrations. Candidates who cannot accurately rank these samples are excluded, ensuring the final sensory panel consists of individuals with verified taste acuity and discrimination skills.

104. (A) Central tendency error
Central tendency error is a common psychological bias where panelists avoid using the extreme ends of a rating scale, preferring to cluster their scores in the middle. This behavior artificially compresses the sensory data, making it difficult to detect significant differences between samples. Rigorous training helps panelists use the entire scale confidently.

105. (C) A is true but R is false.
Paired-comparison tests are discriminative sensory methods that can indeed be directional or non-directional. However, in a directional paired-comparison test, panelists must identify which of two samples possesses more of a specific attribute, such as sweetness. In contrast, a non-directional test asks panelists simply to identify if any difference exists between the two samples.

106. (B) Contain discrete numbers or defined categories at intervals
Structured scoring scales are sensory tools that contain discrete numbers or clearly defined descriptive categories at regular intervals along the scale. This design provides panelists with explicit reference points, enhancing scoring consistency and reproducibility. This structured format differs from unstructured scales, which use a continuous line without intermediate marks or categories.

107. (A) Radar plot
Quantitative Descriptive Analysis utilizes a unique graphical format known as a radar plot, or spider web chart, to present the sensory profile consensus of a product. In this plot, each attribute is represented by an axis radiating from the center. Connecting these points creates a visual pattern, facilitating rapid comparison between different product formulations.

108. (C) Maximum intensity ($I_{\max}$)
In Time-Intensity analysis, the maximum intensity parameter mathematically represents the highest level of sensation perceived by the

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148. (C) Consuming spicy food or smoking within fifteen minutes
Maintaining sensory acuity requires panelists to avoid certain physiological conditions immediately before an evaluation session. Consuming highly spiced foods, chewing gum, or smoking within fifteen minutes of a test is strictly prohibited. These activities cause physiological adaptation, chemical irritation, and residual oral flavors that mask subtle taste differences, compromising the accuracy of the panel.

149. (A) Lack familiarity with the evaluation products and confidence
The error of central tendency is a common psychological bias observed during scaling tasks in sensory evaluation. This bias is particularly prevalent when panelists lack familiarity with the product category or lack confidence in making distinct assessments. In these cases, evaluators tend to score samples toward the middle of the scale to avoid extreme judgments.

150. (D) Odd sample out of three
The triangle test is a classic sensory method used to establish whether a detectable difference exists between two samples. Panelists receive three coded samples simultaneously, where two are identical and one is different. The panelist is instructed to taste all three and identify the odd sample, making it a highly reliable forced-choice method.

151. (B) A continuous line with descriptive end-anchors and no mid-divisions
An unstructured line scale is a scaling technique commonly used in descriptive sensory profiling. It consists of a continuous horizontal line, typically ten or fifteen centimeters in length, containing only verbal descriptions at each end-anchor. Panelists record their response by making a vertical mark along the line, providing highly sensitive, continuous data.

152. (C) The overall balance and blending of the key flavor notes
In the flavor profile method, amplitude is a specific qualitative term assessed by the panel. It represents the overall degree of balance, blending, and integration among the individual flavor notes detected in a product. A high amplitude score indicates that the flavor components harmonize effectively, without any single note overpowering the entire profile.

153. (D) Temporal Dominance of Sensations (TDS)
Temporal Dominance of Sensations is an advanced sensory methodology designed to capture multidimensional changes during food consumption. This technique requires panelists to continuously monitor multiple attributes during mastication. Panelists select which specific attribute dominates their attention at any given second, providing a temporal map that displays the evolving profile of the sample over time.

154. (A) Reduce complex multi-sensor data into 2D or 3D plots
Electronic nose systems contain multiple chemical sensors that generate complex, high-dimensional datasets. To interpret these patterns, software applies Principal Component Analysis. This multivariate statistical technique simplifies the data by reducing its dimensions, allowing researchers to visualize sample classifications as distinct clusters on two-dimensional or three-dimensional plots based on overall volatile profiles.

155. (B) Having low solids, low fat, or dilution with water
A flat flavor defect in liquid milk describes a lack of characteristic richness and mouthfeel. This sensory defect is typically caused by physical factors, such as low total solids, low fat content, or accidental dilution with water. These conditions reduce the concentration of key compounds, leading to a thin and bland flavor profile.

156. (D) A is false but R is true.
Assessing butter directly at refrigerator temperature prevents accurate flavor evaluation because cold temperatures suppress the release of volatile compounds. Tempering butter to approximately thirteen degrees Celsius is necessary to allow proper melting. This melting facilitates the volatilization of critical flavor compounds, enabling panelists to accurately perceive and assess the full sensory profile.

157. (A) Slit or mechanical openness
During cheese evaluation, structural defects are assessed visually and tactilely. The presence of deep, irregular splits, cracks, or lines within the cheese body is known as slit or mechanical openness. This occurs when gas produced by non-starter bacteria cannot escape, or when

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curds are incompletely fused, contrasting with the smooth, round eyes of Swiss-type cheeses.

158. (C) Smooth, uniform, and resembling the original unfrozen mix
Meltdown is a critical quality attribute evaluated during ice cream sensory grading. A desirable meltdown occurs when a sample placed at room temperature melts into a smooth, uniform liquid that resembles the original unfrozen mix. It should not show whey syneresis, excessive foam retention, or curdiness, which indicate emulsion instability or poor formulation.

159. (D) Underwent lipolysis from residual lipase activity or microbes
A rancid flavor in khoa is a serious sensory defect indicating fat degradation. This off-flavor arises when the lipid fraction undergoes lipolysis, which is initiated either by heat-resistant native milk lipases or by microbial enzymes. This chemical reaction releases free butyric and other short-chain fatty acids, producing a characteristic pungent and bitter flavor profile.

160. (C) The coagulation temperature and pH
The final body and texture of heat-acid coagulated dairy products like paneer and chhana are heavily influenced by processing parameters. The specific temperature and pH during coagulation are the most critical factors. These parameters dictate the rate of protein precipitation, moisture entrapment, and the overall density of the resulting curd network, yielding spongy or firm characteristics.

161. (C) 4.4 - 4.6
Set dahi requires controlled lactic acid fermentation to achieve its ideal gel structure and flavor. The typical optimal pH range for set dahi is between 4.4 and 4.6. This acidity corresponds to the isoelectric point of casein, which facilitates stable gel formation, while preventing excessive sourness associated with lower pH values.

162. (D) P-2, Q-3, R-4, S-1
Scorecards utilize specific criteria to standardize the sensory evaluation of different dairy products. Liquid milk grading assigns maximum points to flavor, penalizing oxidized notes. Ice cream scorecard emphasizes physical melting and internal iciness. Butter evaluation focuses on spreadability and visual mottling, whereas Cheddar cheese grading assesses key attributes like eye-formation and sharp aged flavor profiles.

163. (A) Affective (Hedonic) testing
Sensory evaluation methods are divided into analytical and affective categories based on their operational objectives. Affective testing, often referred to as hedonic testing, specifically measures product acceptability based on individual preferences and personal liking. These studies utilize untrained consumer panels to determine market potential and overall consumer satisfaction with a developed food item.

164. (C) Hydrogen ions (hydronium protons)
Sour taste perception is a basic gustatory sensation triggered by specific chemical properties in food. It is fundamentally a physiological response of taste receptor cells to the concentration of free hydrogen ions, or hydronium protons, present in acidic solutions. These ions block potassium channels on taste cells, initiating depolarization and neural signaling to the brain.

165. (A) The roof of the nasal cavity
The human olfactory system utilizes specialized anatomical structures to detect airborne volatile chemicals. The olfactory epithelium is located in a protected region at the very roof of the nasal cavity, directly below the cribriform plate of the ethmoid bone. This specialized tissue contains millions of olfactory sensory neurons that bind odorant molecules during breathing.

166. (D) Creamy coating/mouthfeel
High-fat dairy products like cream and butter produce a distinct tactile sensation during oral processing. When these products are masticated, the body temperature melts the fat, creating a physical barrier and coating over oral tissues. This phenomenon is perceived as a rich, creamy coating or mouthfeel, which reduces friction and enhances palatability.

167. (B) In a logarithmic manner
Fechner's Law is a fundamental psychophysical principle derived from Weber's findings regarding human perception. This law mathematically models sensory response, asserting that the magnitude of subjective sensation increases arithmetically as the physical intensity of the stimulus increases in a logarithmic manner. This relationship helps explain how humans perceive wide ranges of light, sound, and taste intensities.

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168. (C) Increased
Sensory thresholds reflect an individual's biological sensitivity to chemical compounds, which can fluctuate over time. If a panelist requires a higher concentration of a substance to notice its presence compared to a previous session, it indicates their biological sensitivity has decreased. Consequently, their mathematical detection threshold for that specific compound has increased.

169. (D) Cohesiveness
Cohesiveness is a critical secondary mechanical parameter evaluated during Texture Profile Analysis. It is defined as the strength of the internal bonds holding the food matrix together. Subjectively, this parameter represents the degree to which a food sample can be deformed and compressed before it physically ruptures, reflecting its structural integrity.

170. (A) Untreated wood
ISO standards for sensory testing facilities mandate strict environmental controls to prevent biased evaluations. When constructing testing booths, materials that are porous or chemically active are discouraged. Untreated wood is highly restricted because it absorbs moisture and retains volatile odor compounds over time, which can contaminate the testing space and cause sensory distraction.

171. (B) Assesses overall product liking, acceptance, or preference
Sensory panels are categorized based on their selection, training, and operational goals. While trained descriptive panels function as objective analytical instruments to identify and quantify product attributes, consumer panels are composed of untrained individuals. Consumer panels are utilized to assess subjective hedonic responses, such as overall product liking, acceptance, or individual preference.

172. (B) Group convergence
Physical design and procedural rules in sensory testing are established to prevent social and cognitive biases. Group convergence is a specific psychological bias that occurs when panelists are allowed to interact or overhear each other. This interaction causes individual members to modify their honest judgments to align with the vocalized opinions or consensus of the group.

173. (A) Binomial distribution
The paired-comparison test is a forced-choice discriminative method where a panelist evaluates two coded samples to identify which has a stronger specific attribute. Because there are only two possible outcomes for each trial, the statistical significance of the collective panel results is calculated using the binomial distribution model to determine if the difference is real.

174. (C) Magnitude estimation
Magnitude estimation is a ratio scaling method developed in psychophysics to bypass the limitations of category scales. In this technique, panelists assign numerical values to their perceived sensations such that the ratios between the assigned numbers reflect the physical ratios of perceived intensities. This provides continuous ratio data suitable for advanced power law modeling.

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175. (D) ANOVA and PCA multivariate techniques
Quantitative Descriptive Analysis generates complex datasets comprising intensity scores across multiple sensory attributes. To draw meaningful conclusions, researchers analyze these multidimensional profiles using advanced statistics. Analysis of Variance determines if differences among samples are statistically significant, while Principal Component Analysis reduces the data dimensionality to display relationships and group samples on visual plots.

176. (C) Attribute intensity on the Y-axis and Time on the X-axis
Time-intensity sensory evaluation tracks how the perception of a single attribute changes over a defined period. The resulting data is visually represented on a two-dimensional line graph. This standard plot features the perceived attribute intensity on the vertical Y-axis and elapsed time on the horizontal X-axis, illustrating parameters like maximum peak and total duration.

177. (B) Generating a distinct electrochemical fingerprint
The electronic tongue functions as an analytical instrument to evaluate liquid systems without human bias. It differentiates among dairy products by exposing its sensor array to dissolved chemical compounds. The interactions at the sensor membranes produce electrical potential changes, which the system compiles to generate a

217. (C) 10 to 12
Establishing a trained descriptive panel requires selecting a suitable group size to ensure statistical power and reliability. While consumer panels require larger numbers, a trained panel functions as an analytical instrument. Sensory standards recommend a minimum of ten to twelve thoroughly calibrated panelists, providing highly consistent, reproducible profiling data for product comparison.

218. (A) Physical presentation properties like cup size or color
The stimulus error is a psychological bias that occurs when a panelist's evaluation is influenced by irrelevant physical characteristics of the sample presentation. For example, variations in cup size, shape, or sample color can create preconceptions about product quality. To prevent this error, all physical presentation properties must remain completely standardized and identical.

219. (B) Sensory fatigue occurs rapidly over five samples
The two-out-of-five test is a highly powerful discriminative sensory method, but its practical application is limited. In dairy product evaluation, especially with products featuring rich, lingering flavors like cheese or butter, tasting five samples causes rapid sensory fatigue. This fatigue and carry-over diminish panelist acuity, leading to inaccurate results during subsequent evaluations.

220. (B) Equal positive and negative levels around a midpoint
The nine-point hedonic scale is a widely recognized tool for measuring consumer product acceptance. It is mathematically and psychologically structured as a balanced scale because it contains an equal number of positive liking categories and negative disliking categories situated symmetrically around a neutral midpoint, which is defined as neither like nor dislike.

221. (A) Flavour Profile Method
The flavor profile method is a pioneer descriptive sensory technique developed in the mid-twentieth century. This methodology utilizes a specialized, highly trained panel to define product characteristics. The panel evaluates individual flavor notes, their order of appearance, and the overall amplitude, which represents the harmony and balance of the complete flavor profile.

222. (C) The sensation capturing most attention at that moment
In Temporal Dominance of Sensations, the concept of dominance is defined from a cognitive perspective. Rather than reflecting the mathematically most intense stimulus, a sensation is considered dominant when it captures the panelist's primary attention at a given second. This method tracks how these dominant perceptions shift during the mastication process.

223. (D) A signal matrix representing global taste profiles
The electronic tongue is an analytical instrument designed to objectively evaluate taste properties. Unlike chemical assays, its output does not yield individual chemical concentrations. Instead, the sensor array generates a signal matrix of electrical potentials. This matrix represents the global taste profile, which is then analyzed using multivariate statistics to classify samples.

224. (C) Malty
A malty flavor in liquid milk is a distinct, undesirable biological sensory defect. This off-flavor arises from microbial contamination, specifically due to the growth of Lactococcus lactis subspecies lactis biovar diacetylactis. These bacteria metabolize milk proteins, degrading amino acids into volatile aldehydes such as three-methylbutanal, which imparts a heavy malty taste.

225. (B) Cohesiveness
Butter texture is evaluated visually and mechanically during sensory grading. A crumbly texture in butter is a physical defect where the product lacks internal cohesiveness. This condition prevents the fat crystals and moisture droplets from forming a closely knit, uniform structure. When sliced or spread, the butter breaks apart easily into coarse, non-cohesive particles.

226. (D) Flat, bland, and lacking sharpness
Acid development during Cheddar cheese manufacturing is critical for shaping its final sensory profile. If lactic acid bacteria fail to produce sufficient acid, the ripening process is compromised. The resulting mature cheese exhibits a flat, bland flavor profile that lacks the characteristic sharp, tangy, and mature notes expected in a high-quality product.

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guide nutrition. The bitter taste modality is uniquely critical because it serves as an essential warning mechanism against toxic compounds, such as poisonous alkaloids frequently found in plants. This physiological alarm system triggers strong aversion, preventing the ingestion of hazardous substances.

188. (B) Olfactory cilia
The human nasal cavity is structurally optimized to maximize volatile detection capacity. The olfactory cilia are hair-like projections extending from olfactory sensory neurons into the mucus layer of the nasal cavity. These structures dramatically increase the available surface area for odorant receptors to bind volatile molecules, enhancing the overall sensitivity of olfactory perception.

189. (A) Transient Receptor Potential (TRP) channels
Thermal and chemical irritation sensations during food consumption are mediated by somatosensory pathways rather than classic taste receptors. Thermal perception, including the sensation of chemical heat from spicy foods, is mediated by Transient Receptor Potential channels. These specialized ion channels are located on trigeminal nerve endings and are activated by temperature changes and active compounds.

190. (C) Sensation magnitude is a power function of stimulus intensity.
Stevens' Power Law is a fundamental psychophysical equation that describes how humans perceive sensory stimuli. The fundamental premise of this law is that perceived sensation magnitude is a power function of physical stimulus intensity. By utilizing a specific exponent for each sensory modality, this model accommodates diverse perceptual behaviors, including response compression and response expansion.

191. (D) Absolute threshold
Sensory evaluation relies on measuring precise physiological limits of human perception. The minimum concentration or physical intensity of a stimulus required for a person to detect its presence is defined as the absolute threshold. Below this specific concentration level, the stimulus remains completely undetectable by the human sensory systems, producing no physiological response.

192. (C) Hardness
Hardness is a primary mechanical texture parameter evaluated in both sensory and instrumental food profiling. Subjectively, it is defined as the physical force required to compress a food sample between the molar teeth during the first bite. Instrumentally, it corresponds to the maximum peak force recorded during the initial compression cycle.

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193. (B) Prevent odor ingress from preparation areas
Sensory laboratory design incorporates environmental engineering to eliminate external bias during evaluations. Maintaining positive air pressure inside testing booths ensures that airflow moves from the booths outward. This pressure differential effectively prevents the ingress of food preparation odors or chemical contaminants from adjacent kitchen areas, keeping the testing environment completely neutral.

194. (D) Trained descriptive panel
Trained descriptive panels are highly specialized groups used in sensory profiling. Typically composed of ten to fifteen members, these panels undergo extensive training to align their perceptions and establish a standardized vocabulary. They function as analytical instruments, providing objective quantitative data on the intensity of specific attributes, rather than expressing personal hedonic preferences.

195. (A) Error of central tendency
Scaling errors can compromise sensory evaluation results if panelists are not properly trained. The error of central tendency is a specific psychological bias where panelists systematically avoid using extreme values at the ends of a scale. Instead, they cluster their scores near the midpoint, which typically happens when they lack confidence or product familiarity.

196. (C) A reference and two coded samples, one matching the reference
The duo-trio test is a classical forced-choice discriminative method. During this test, the panelist is first presented with a designated reference sample, followed by two coded samples. One of these coded samples is identical to the reference, and the other is different. The panelist must identify which coded sample matches the reference.

distinct, reproducible electrochemical fingerprint representing the global taste profile.

178. (D) Ultraviolet and blue light (< 500 nm)
Milk packaged in transparent containers is highly susceptible to photo-oxidation, which degrades both nutritional and sensory quality. This reaction is catalyzed by riboflavin absorbing light energy. The primary wavelengths responsible for initiating this oxidation are in the ultraviolet and blue light range below five hundred nanometers, producing characteristic off-flavors described as cabbage-like or cardboardy.

179. (A) Microbial growth in the cream before churning
A yeasty or cheesy flavor is a severe sensory defect in butter. This flavor profile typically indicates contamination and subsequent microbial growth in the starting cream prior to the churning process. Uncontrolled growth of yeasts, molds, or non-lactic bacteria metabolizes lactose and proteins, generating volatile off-flavor compounds that carry over into the finished butter.

180. (C) Smooth, firm, waxy, and free of mechanical openings
Cheddar cheese quality standards dictate specific requirements for ideal body and texture. A high-quality aged Cheddar must possess a smooth, firm, and waxy body. When sliced, the cheese should show good cohesiveness, a clean breakdown on the palate, and remain completely free from undesirable slit or irregular mechanical openings that indicate manufacturing flaws.

181. (A) Salty/Whey flavor
Ice cream mixes utilize various dairy solids to achieve proper structure and solids-not-fat content. If poor-quality sweet whey powder is incorporated or used in excessive ratios, it introduces high mineral concentrations into the mix. This formulation error imparts a distinct salty, whey-like flavor defect, which diminishes the clean sweetness expected in the final product.

182. (D) High starting milk acidity promoting Maillard browning
Achieving the correct color is essential during peda manufacturing. If a white peda variety is intended, the development of a dark brown color is graded as a visual defect. This excessive browning is chemically accelerated when the starting milk has high acidity, which lowers the pH and promotes rapid Maillard browning reactions during heat processing.

183. (B) The starting milk is acidic or fermented before boiling
Paneer should ideally possess a compact, firm, and cohesive curd structure. A spongy or highly porous texture is a physical defect that commonly arises when the starting milk has undergone prior lactic fermentation, making it acidic. This initial acidity alters casein hydration and destabilizes micelles prematurely before heat-acid coagulation, producing a weak, aerated matrix.

184. (B) Acetaldehyde
Yogurt sensory quality is highly characterized by its unique acidic and aromatic volatile profile. The pleasant, characteristic green-apple-like flavor in fresh yogurt is primarily attributed to acetaldehyde. This volatile compound is synthesized by the starter culture bacteria, particularly Lactobacillus bulgaricus, through the metabolic conversion of milk threonine during the fermentation process.

185. (D) Crystallization of lactose upon moisture absorption
Caking is a major physical defect occurring in milk powders during storage, especially under high humidity. This defect is physically initiated when amorphous lactose absorbs moisture from the environment. Once the moisture level rises, the lactose transitions into a crystalline monohydrate state, releasing bound water and forming rigid inter-particle bridges that result in hard lumps.

186. (A) Analytical testing treats the panelist as an instrument
Sensory science distinguishes between objective and subjective methodologies based on testing parameters. Analytical testing relies on highly trained, calibrated panels, treating individual panelists as objective instruments to detect and measure attributes. Conversely, affective testing focuses on untrained consumers to gauge subjective hedonic parameters, such as overall product liking and individual consumption preferences.

187. (B) Warning mechanism against toxic compounds
From an evolutionary perspective, basic taste modalities function to protect organisms and

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207. (D) Incomplete drainage of chakka whey
Shrikhand is a semi-solid, sweet-sour fermented dessert prepared from chakka. A wheyey or watery appearance on the surface of shrikhand is graded as a quality defect. This defect typically results from the incomplete drainage of whey during chakka preparation, which leaves excessive free water trapped in the curd that later leaks out during storage.

208. (C) Protein denaturation causing incomplete dissolution
The insolubility index of milk powder is an objective physical parameter directly related to its sensory and reconstitution quality. This metric indicates the volume of insoluble sediment remaining after powder rehydration. It reflects protein denaturation, particularly of casein micelles, caused by excessive heat exposure during drying, which prevents complete dissolution of the powder in water.

209. (B) All five of the fundamental human senses
Organoleptic evaluation is a sensory assessment method used to determine the quality of food products. It involves using all five of the fundamental human senses, including sight, smell, taste, touch, and hearing. This comprehensive evaluation allows assessors to evaluate diverse attributes like visual appearance, volatile aroma, basic taste, oral texture, and auditory crunchiness.

210. (D) Filiform
Taste buds are housed on specialized epithelial structures called papillae located on the tongue. Among the four primary types of papillae, filiform papillae are unique because they do not contain any taste receptors. Instead, these mechanical structures provide friction on the tongue surface, assisting in the physical manipulation and movement of food during mastication.

211. (A) Retro-nasal olfaction
Olfaction occurs via two pathways depending on the route volatile compounds travel. Retro-nasal olfaction describes the detection of volatile food molecules that originate in the oral cavity during consumption. As food is masticated and swallowed, these compounds travel from the pharynx up through the nasopharynx to stimulate the olfactory receptors, contributing significantly to complex flavor perception.

212. (C) P-2, Q-3, R-4, S-1
Discriminative sensory tests are chosen based on specific research objectives. The triangle test requires identifying the single odd sample among three. The paired-comparison test compares two samples for a specific attribute. The ranking test is used to order multiple samples, while the duo-trio test asks panelists to identify which of two coded samples matches a reference.

213. (A) Increases proportionally
Weber's Law mathematically represents the human capacity to detect changes in physical stimuli. This psychophysical law implies that the just noticeable difference is a constant proportion of the baseline stimulus. Consequently, as the background intensity of a sensory stimulus increases, the minimum physical change required for an observer to notice a difference increases proportionally.

214. (D) Sensory adaptation
Sensory adaptation is a physiological phenomenon that occurs when receptors are exposed to a stimulus over an extended period. For instance, repeatedly evaluating highly sweet samples desensitizes sweetness receptors. When the panelist subsequently evaluates a mildly sweet sample, they perceive it as completely unsweetened due to this temporary reduction in receptor sensitivity.

215. (B) Gumminess
Texture Profile Analysis yields several primary and secondary mechanical parameters that characterize food structure. Gumminess is a secondary mechanical parameter derived mathematically from TPA curves. It is calculated by multiplying hardness by cohesiveness. This property describes the energy required to disintegrate a semi-solid food product to a state ready for swallowing.

216. (C) Balanced and randomized
Sample presentation order must be strictly controlled during sensory testing to prevent psychological errors, such as carry-over effects or position bias. To ensure scientific validity, the sequence of samples presented to panelists should be balanced and randomized. This means every sample appears in each position an equal number of times across the panel.

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197. (A) 15-cm line scale with end anchors
Scaling techniques dictate how quantitative data is collected during sensory profiling. An unstructured rating scale is characterized by a lack of numerical divisions or discrete intervals along its path. A classic example is a fifteen-centimeter horizontal line containing only descriptive verbal anchors at each end, allowing panelists to record their perceptions continuously.

198. (D) Stone and Sidel
Quantitative Descriptive Analysis is a landmark sensory profiling method developed in the twentieth century. This scientific methodology was originally developed by Herbert Stone and Joel Sidel. Their approach established key sensory principles, including the use of trained panels, consensus vocabulary development, unstructured line scales, and multivariate statistical tools to analyze resulting profiles.

199. (B) Identifies the dominant attribute over time from a given list
Dynamic sensory profiling methods capture the temporal nature of flavor release during mastication. Temporal Dominance of Sensations differs from traditional time-intensity testing. While time-intensity measures the changing strength of a single predetermined attribute, this method requires panelists to select which specific attribute is dominant or captures their attention at any given second.

200. (C) Filtered air or pure nitrogen gas
Electronic nose systems utilize sensitive chemical sensor arrays to analyze headspaces. Before introducing a test sample, the sensors must undergo calibration to establish a stable reference baseline. This is achieved by purging the sensor chamber with filtered air or pure nitrogen gas, which removes residual volatiles from previous runs and resets the sensor resistance.

201. (D) Oxidized
An oxidized flavor in liquid milk is a serious sensory defect that degrades product quality. This off-flavor is chemically characterized by a distinct cardboard-like, metallic, or oily taste. It is initiated by lipid peroxidation of unsaturated fatty acids in the milk fat globule membrane, which is catalyzed by exposure to light or copper ions during processing.

202. (A) Cattle feeding on winter grass, raising high-melting fats
Butter texture is highly dependent on the fatty acid composition of the milk fat. A sticky body in butter is a defect often related to agricultural factors, such as cattle feeding on dry winter grass. This diet increases the proportion of high-melting-point saturated fatty acids, leading to hard butter that sticks to triers during sensory evaluation.

203. (B) Meltability and stretchability
Mozzarella cheese is heavily utilized in baking applications, particularly as a pizza topping. The sensory and functional performance of this cheese during baking is objectively evaluated using key physical parameters. Meltability and stretchability are the primary functional metrics, describing how the cheese flows and forms continuous, elastic strings when subjected to high thermal conditions.

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204. (B) 15-25 micrometers
Sandiness in ice cream is an irreversible textural defect that ruins product quality. This defect occurs when lactose crystals grow large enough to be detected by human oral mechanoreceptors. When these crystals exceed approximately fifteen to twenty-five micrometers in size, they impart a gritty, sand-like texture to the palate, which is highly penalized on scorecards.

205. (A) Sugar and flavorings, shaped into pieces
Khoa and peda are closely related traditional Indian dairy products, but they display distinct sensory and physical differences. Khoa is a plain, concentrated, and desiccated milk product used as a base. Peda is manufactured by incorporating sugar and flavorings like cardamom or saffron into khoa, followed by portioning and shaping the mixture into distinctive round pieces.

206. (A) Both A and R are true and R is the correct explanation of A.
High-quality paneer requires a compact, firm, and cohesive body to slice well and retain its shape during cooking. This ideal physical structure is achieved by subjecting the hot acid coagulum to mechanical pressing. This pressing step physically expels excess whey and forces the precipitated casein micelles to form a closely knit, resilient, three-dimensional protein network.

227. (A) Mix formulation and storage temperature control

An icy texture in ice cream is a serious, undesirable physical defect. This condition is fundamentally a failure of mix formulation and subsequent storage temperature control. Insufficient stabilizer levels or inadequate total solids allow water molecules to migrate and freeze into large, detectable ice crystals, particularly when the storage temperature fluctuates during distribution.

228. (C) Use of high-acid milk prior to heat desiccation

High-quality khoa is characterized by a rich, sweet, and caramelized flavor. If the finished product exhibits a sour taste, it represents a sensory defect. This sourness is typically caused by using high-acid starting milk prior to the heat desiccation process. The residual lactic acid remains concentrated in the product, imparting an undesirable sour profile.

229. (A) Loose and crumbly

Paneer must maintain a cohesive structure that allows clean slicing without disintegrating. A loose and crumbly texture is a defect where the product lacks structural integrity and falls apart when cut. This defect typically results from improper pressing duration, low pressing weight, or insufficient coagulation temperature, which prevents the curd from fusing properly.

230. (D) Contamination by undesirable yeasts or molds

During the sensory grading of yogurt, flavor profiles must be clean and acidic. A yeasty or fruity flavor is a severe sensory defect that is heavily penalized. This off-flavor indicates contamination by undesirable wild yeasts or molds during processing or packaging. These microbes ferment lactose into ethanol and esters, altering the product profile.

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CHAPTER 12

Management & Food Safety Aspects With Reference to Dairy Plant Operations

2023

1. What is the primary chemical composition of traditional milk stone deposited on heated dairy equipment surfaces?
(A) Calcium phosphates enmeshed with denatured proteins and lipids
(B) Denatured whey proteins combined with crystalline lactose residues
(C) Crystallized lactose complexes combined with intact casein micelles
(D) Insoluble calcium carbonate precipitates derived from hard water

2015

2. Which component of milk is most responsible for the initial layer of fouling on stainless steel heat exchanger surfaces at temperatures above 65 degrees Celsius?
(A) Lactose
(B) Milk fat globule membrane
(C) Beta-lactoglobulin
(D) Calcium chloride

2025

3. What defines Type A milk fouling deposits in thermal processing equipment?
(A) Soft, protein-rich deposits formed between 75 and 85 degrees Celsius
(B) Hard, brittle mineral-rich scales deposited at temperatures above 110 degrees Celsius
(C) Lipid-based films accumulated inside refrigerated raw milk storage tanks
(D) Dense bacterial biofilms established during extended continuous operations

2002

4. In the context of dairy equipment fouling, how does the presence of ionic calcium influence protein deposition?
(A) It operates as a solvent, effectively preventing beta-lactoglobulin aggregation
(B) It buffers the structural pH of milk, leading to decreased precipitation
(C) It electrostatically repels lipid droplets from the thermal boundary layer
(D) It bridges proteins to the stainless steel surface, worsening fouling

2005

5. Which cleaning mechanism is most critical for the effective removal of denatured protein films from dairy equipment?
(A) Saponification
(B) Peptization
(C) Emulsification
(D) Sequestration

2007

6. Why do lipid deposits typically require alkaline conditions for effective removal during dairy equipment cleaning?
(A) Alkaline solutions lower the boiling point of the washing fluid
(B) High pH denatures the remaining lipase enzymes in the deposit
(C) Hydroxyl ions saponify triglycerides into soluble soaps
(D) Alkaline conditions induce the crystallization of fats for physical abrasion

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2022

7. What is the major difference between Type A and Type B dairy fouling deposits?
(A) Type A is rich in calcium phosphates, whereas Type B consists primarily of crystallized lactose molecules
(B) Type A forms rapidly under high temperatures, while Type B accumulates solely under cold storage conditions
(C) Type A is easily dissolved using mild acid alone, whereas Type B requires intensive mechanical scrubbing
(D) Type A is protein-rich (lower temperatures); Type B is mineral-rich (higher temperatures)

2008

8. Which of the following represents the correct sequence of events during the thermal fouling of beta-lactoglobulin on a stainless steel surface?
(A) Unfolding of the native protein, transport

to the surface, aggregation and adherence, cross-linking
(B) Aggregation and adherence, transport to the surface, unfolding of the native protein, cross-linking
(C) Cross-linking, unfolding of the native protein, aggregation and adherence, transport to the surface
(D) Transport to the surface, cross-linking, unfolding of the native protein, aggregation and adherence

2004
9. What is the primary disadvantage of allowing milk stone to accumulate on pasteurizer plates?
(A) It artificially increases the volumetric flow rate of milk through the system
(B) It acts as an insulator, reducing heat transfer efficiency
(C) It prematurely neutralizes chemical alkaline detergents during the CIP cycle
(D) It triggers a rapid, immediate drop in the pH level of the processed milk

2010
10. Which physical force is predominantly responsible for the initial reversible attachment of soil particles to dairy equipment surfaces?
(A) Covalent chemical bonding
(B) Van der Waals forces
(C) Electrostatic ionic bonding
(D) Metallic surface bonding

2008
11. Which water quality parameter is the most critical driver of scale formation when alkaline detergents are used in dairy plants?
(A) Total water hardness (calcium and magnesium)
(B) Dissolved oxygen concentration in supply lines
(C) Free residual chlorine levels after treatment
(D) Biological oxygen demand of incoming raw water

2014
12. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): Hard water significantly reduces the cleaning efficiency of soap-based detergents in dairy plants.
Reason (R): Calcium and magnesium ions react with soaps to form insoluble precipitates known as scum.
Which of the following is correct?
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2021
13. Which water conditioning technology utilizes ion exchange resins to replace scale-forming ions with sodium ions?
(A) Reverse Osmosis
(B) Ultraviolet irradiation
(C) Activated carbon filtration
(D) Water softening

2024
14. What is the primary function of adding sequestering agents to dairy cleaning solutions formulated with hard water?
(A) To significantly lower the interfacial surface tension of the water
(B) To elevate the thermal and kinetic energy of the circulating solution
(C) To bind hard water ions into soluble complexes, preventing scale
(D) To adjust and neutralize the excess alkalinity of the active detergent

2013
15. Which of the following issues is most directly caused by high iron content in the water supply of a dairy plant?
(A) Rapid degradation and cracking of synthetic rubber gaskets
(B) Staining of steel surfaces and metallic off-flavors in milk
(C) Excessive, unwanted foaming during the high-turbulence CIP wash cycle
(D) Accelerated chemical breakdown and neutralization of acid sanitizers

2021
16. In the context of dairy plant water quality, what does the term 'temporary hardness' specifically refer to?
(A) Hardness caused by dissolved calcium and magnesium sulfates along with chloride salts
(B) Hardness that continuously dissipates when water is exposed directly to ultraviolet light
(C) Hardness directly resulting from the heavy presence of trace metals like lead and copper
(D) Hardness from calcium and magnesium bicarbonates that precipitates on boiling

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(A) Reynolds number
(B) Nusselt number
(C) Froude number
(D) Prandtl number

2001

84. According to the interaction of TACT parameters, if the concentration of the detergent is significantly reduced for environmental reasons, how must the other parameters typically be adjusted to maintain cleaning efficacy?
(A) Action must be reduced down to a strictly laminar flow state
(B) Both wash temperature and exposure time must be decreased
(C) Circulation time must be reduced to prevent surface corrosion
(D) Temperature or wash time must be appropriately increased

2019

85. Consider the following statements regarding the optimization of CIP parameters:
I. Increasing the temperature of a caustic wash infinitely improves cleaning efficacy without drawbacks.
II. Excessive fluid velocity can cause pressure drops and pump cavitation, leading to inadequate cleaning.
III. TACT parameters are deeply interdependent; altering one requires compensation in the others.
Which of the above statement(s) is/are correct?
(A) I and II
(B) II and III
(C) I and III
(D) I

2017

86. How does an excessive increase in the 'Temperature' parameter (e.g., boiling the caustic solution) negatively impact a CIP process?
(A) It drastically increases the physical density of the cleaning fluid, stopping automated pump flow
(B) It chemically converts the active sodium hydroxide molecules into a highly corrosive acidic compound
(C) It can bake proteins onto the surface and cause thermal shock to equipment
(D) It permanently magnifies the micro-scale surface roughness profile of sanitary stainless steel

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2021

87. During tank cleaning, the 'Action' parameter of TACT is provided differently than in pipelines. How is the mechanical action primarily generated on the vertical walls of a dairy silo during CIP?
(A) By generating highly turbulent fluid velocity parallel to the internal metal surface
(B) By continuous, high-volume injection of pressurized air bubbles into the liquid phase
(C) By utilizing high-frequency ultrasonic transducers mounted externally on the vessel walls
(D) By the cascading falling film distributed by the spray ball

2010

88. If a CIP circuit experiences a sudden drop in flow rate, which TACT parameter is immediately compromised?
(A) Action
(B) Time
(C) Concentration
(D) Temperature

2013

89. Which of the following is a direct consequence of inadequate 'Time' during the chemical wash phase of CIP?
(A) Severe, excessive chemical corrosion of the polished stainless steel
(B) Inadequate wetting, penetration, and soil suspension
(C) Immediate and rapid precipitation of insoluble water hardness minerals
(D) Complete transformation of turbulent fluid flow into laminar fluid flow

2005

90. When optimizing the 'Concentration' parameter, why is "more" not always "better"?
(A) Extremely high chemical concentrations completely and permanently stop the natural saponification process
(B) Excess concentrations cause residues, waste treatment burdens, and equipment corrosion
(C) High concentrations render the active wash fluid completely transparent, making flow patterns hard to track
(D) Excessive concentrations drastically lower the thermal boiling point of the circulating wash water dangerously

2001

91. What is the defining operational characteristic of a Cleaning-Out-of-Place (COP) system in a dairy plant?

complexes
4. Alkaline hydrolysis of fats into water-soluble soaps

(A) P-4, Q-3, R-1, S-2
(B) P-3, Q-4, R-2, S-1
(C) P-1, Q-2, R-3, S-4
(D) P-4, Q-2, R-1, S-3

2006

26. Surfactants form micelles in the cleaning solution when they reach a specific concentration. What is this critical parameter called?
(A) Minimum Inhibitory Concentration (MIC)
(B) Critical Micelle Concentration (CMC)
(C) Maximum Wetting Point (MWP)
(D) Isoelectric Point (pI)

2017

27. How does a chelating agent improve the efficacy of a dairy detergent?
(A) By forming coordination bonds with metal ions to prevent scale
(B) By creating a highly durable physical barrier between the soil and the stainless steel
(C) By significantly increasing the foaming capacity of the solution to scrub the soil
(D) By continuously generating oxygen free radicals that destroy bacterial cell walls

2025

28. Which of the following phenomena is a major disadvantage if excessive foaming occurs during Cleaning-In-Place (CIP) circulation?
(A) Foam drastically increases the overall thermal conductivity and heat loss of the circulating pipes
(B) Foam permanently denatures and degrades the passive structural integrity of the stainless steel
(C) Foam causes pump cavitation, reducing fluid velocity needed for mechanical cleaning
(D) Foam artificially elevates the localized pH of the cleaning solution well beyond safe operational limits

2011

29. What is the fundamental difference between sequestration and precipitation when managing hard water in detergency?
(A) Sequestration immediately forms insoluble particles, whereas chemical precipitation keeps minerals completely dissolved
(B) Sequestration functions strictly as an acidic process, whereas standard chemical precipitation only occurs in neutral pH
(C) Sequestration applies exclusively to complex proteins, while physical precipitation applies only to dissolved mineral ions
(D) Sequestration keeps minerals soluble, while precipitation forms insoluble settling particles

2019

30. Which term best describes a surfactant molecule that possesses both a hydrophilic head and a hydrophobic tail?
(A) Isotropic
(B) Hygroscopic
(C) Amphiphilic
(D) Zwitterionic

2008

31. Which of the following chemicals acts as the primary source of alkalinity in most heavy-duty dairy CIP detergents?
(A) Neutral sodium chloride salt
(B) Alkaline sodium hydroxide
(C) Buffered sodium bicarbonate
(D) Concentrated citric acid

2016

32. What specific functional role do silicates (such as sodium metasilicate) fulfill in an alkaline dairy detergent formulation?
(A) They primarily initiate and catalyze the saponification of complex milk fats
(B) They act as highly powerful chelating agents for multi-valent calcium ions
(C) They serve effectively as the primary chemical antimicrobial sanitizing agent
(D) They provide corrosion inhibition for soft metals like aluminum

2013

33. Consider the following statements regarding the components of alkaline dairy detergents:
I. Sodium hydroxide provides the strong alkalinity needed for peptizing proteins.
II. Polyphosphates act primarily to prevent the precipitation of hard water minerals.
III. EDTA is heavily utilized for its powerful saponification properties.

Which of the above statement(s) is/are correct?
(A) I and III
(B) I and II
(C) II and III
(D) I

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(B) Sodium hypochlorite diluted to 50 ppm
(C) Standard commercial-grade Iodophors
(D) Low-concentration environmental QACs

2009

68. Why must ozone be generated on-site at the dairy plant rather than being purchased in bulk cylinders?
(A) Bulk transport is strictly prohibited and illegal due to rigid agricultural safety regulations
(B) It requires continuous, instantaneous mixing with incoming raw milk inside storage tanks
(C) It instantly solidifies into a dangerous crystalline mass under high pressure during transport
(D) It is unstable and decomposes back into diatomic oxygen rapidly

2004

69. When using Peracetic acid (PAA) in a CIP system, what is an important consideration regarding plant infrastructure?
(A) It initiates extreme, catastrophic stress corrosion cracking in high-quality 316 stainless steel
(B) PAA solutions emit pungent vapors, requiring adequate handling area ventilation
(C) It necessitates the expensive installation of high-intensity UV lights inside the CIP piping networks
(D) It rapidly degrades and dissolves standard sanitary silicone gaskets into a highly viscous liquid state

2018

70. How does chlorine dioxide specifically disrupt bacterial cells?
(A) It rapidly and completely dehydrates the biological cell through reverse osmosis mechanisms
(B) It forms a tight, impermeable physical encapsulation around the structural bacterial cell wall
(C) It oxidizes cell membrane amino acids, inhibiting protein synthesis
(D) It biochemically forces the haploid cell to prematurely and rapidly undergo cellular mitosis

2022

71. In a standard multi-use Cleaning-In-Place (CIP) system, what is the primary purpose of the 'intermediate rinse' step?
(A) To completely sterilize all product-contact equipment surfaces prior to initiating the next production run
(B) To rapidly cool the entire piping system down to ambient room temperature immediately after thermal washing
(C) To chemically dissolve and disperse complex lipid deposits left behind by the initial warm-water pre-rinse
(D) To flush out alkaline detergent residues before acid circulation, preventing neutralization

2021

72. Which component of an automated CIP system ensures that cleaning solutions are directed accurately through the correct processing circuits without manual intervention?
(A) The routing mix-proof valve matrix
(B) The plate-and-frame heat exchanger
(C) The automated chemical balance tank
(D) The high-pressure homogenizer bypass

2016

73. What is the fundamental difference between a single-use CIP system and a multi-use (recovery) CIP system?
(A) Single-use systems rely exclusively on mechanical scrubbing and completely bypass sanitizers
(B) Recovery systems reuse detergents, while single-use systems discharge them after one cycle
(C) Single-use systems are designed to continuously circulate unheated, ambient cold water
(D) Recovery systems operate under manual intervention, whereas single-use systems are automated

2017

74. During the pre-rinse phase of a typical dairy CIP cycle, why is lukewarm water (typically 35-45 degrees Celsius) preferred over hot water (above 70 degrees Celsius)?
(A) Hot water causes flash boiling and immediate thermal vaporization of the remaining milk film
(B) Hot water denatures residual milk proteins, causing them to bake onto surfaces
(C) Lukewarm water exhibits significantly superior chemical and thermal sterilizing properties
(D) Lukewarm water chemically neutralizes the natural pH value of raw milk much more effectively

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produce hazardous toxic chloramines
(D) It is completely incompatible with all commercial sanitizing agents used in plants

2001

44. Phosphoric acid is often blended with nitric acid in dairy acid detergents. What specific benefit does phosphoric acid provide?
(A) It acts as a primary sanitizing agent targeting resilient bacterial spores
(B) It dissolves complex hydrophobic lipid matrices significantly better than nitric acid
(C) It provides detergency and is less corrosive to stainless steel than other mineral acids
(D) It effectively neutralizes calcium ions without altering the baseline pH of the system

2018

45. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): Organic acids like citric acid are frequently used for manual cleaning of sensitive dairy equipment rather than strong inorganic acids.
Reason (R): Organic acids are milder, safer for personnel to handle, and less corrosive to sensitive metals and soft seals.
Which of the following is correct?
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2023

46. What specific chemical interaction allows acid detergents to effectively remove milk stone?
(A) The concentrated acid rapidly hydrolyzes the structural peptide bonds inside the milk proteins
(B) The acid formulation completely oxidizes the heavy mineral matrix into carbon dioxide gas
(C) Hydrogen ions convert insoluble calcium phosphates into soluble salts
(D) The chemical acid acts as a surfactant, lifting the intact mineral scale from the metal surface

2011

47. Which of the following operational parameters is typical for a standard nitric acid CIP circulation in a dairy plant?
(A) Concentration of 0.05-0.1% at 20-30 degrees Celsius
(B) Concentration of 0.5-1.0% at 60-70 degrees Celsius
(C) Concentration of 2.0-3.0% at 120 degrees Celsius
(D) Concentration of 5-10% at 90-100 degrees Celsius

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2008

48. What environmental concern is specifically associated with the excessive use of phosphoric acid detergents in dairy plants?
(A) Severe chemical depletion of the upper atmospheric ozone layer
(B) Continuous emission of hazardous volatile organic compounds (VOCs) into the air
(C) Long-term accumulation of hazardous toxic heavy metals in the agricultural soil
(D) Eutrophication of receiving waters due to high phosphorus discharge

2024

49. When using an acid wash, why is it critical to ensure that a thorough pre-rinse and alkaline wash have been completed beforehand?
(A) Acids precipitate remaining proteins onto the surface, making them very hard to remove
(B) Acids instantly vaporize and release hazardous fumes if they contact raw milk residues directly
(C) The preceding alkaline wash is critically needed to pre-heat the pipes before cold acid is introduced
(D) Acids can only function at high chemical efficiency in the presence of residual alkaline molecules

2012

50. Consider the following statements regarding acidic dairy detergents:
I. Nitric acid is a strong oxidizer that helps passivate stainless steel surfaces.
II. Phosphoric acid is highly corrosive to stainless steel and is only used for plastic piping.
III. Organic acids like gluconic acid act as both weak acids and chelating agents.
IV. Acid detergents are primarily utilized to saponify complex lipid deposits.
Which of the above statement(s) is/are INCORRECT?
(A) II, III and IV
(B) I and III

2025

17. Which threshold value of water hardness generally necessitates the mandatory use of water softening equipment in a dairy CIP system to prevent immediate scaling?
(A) Hardness levels falling below 5 ppm
(B) Hardness levels between 10 and 20 ppm
(C) Hardness levels between 50 and 60 ppm
(D) Hardness levels exceeding 150 to 200 ppm

2017

18. Arrange the following steps of the water softening cycle using a cation-exchange resin in the correct order.
I. Backwashing to remove particulate matter
II. Service cycle (hard water flows through resin)
III. Fast rinsing to remove excess brine
IV. Regeneration with concentrated sodium chloride solution
(A) I, II, IV, III
(B) II, I, IV, III
(C) IV, III, II, I
(D) II, IV, I, III

2010

19. What is the primary reason why high chloride levels in plant water are highly detrimental to dairy processing equipment?
(A) Chlorides induce pitting and stress corrosion cracking in stainless steel
(B) Chlorides drastically lower the chemical effectiveness of quaternary ammonium sanitizing compounds
(C) Chlorides trigger the premature precipitation of lactose molecules during flash chilling
(D) Chlorides react directly with milk fat globules to generate unpleasant volatile off-odors

2018

20. Which analytical method is classically used to determine the total hardness of water intended for dairy plant cleaning?
(A) High-Performance Liquid Chromatography coupled with UV-Vis detection (HPLC)
(B) Gas Chromatography-Mass Spectrometry with electron ionization (GC-MS)
(C) Kjeldahl nitrogen digestion followed by acid-base distillation method
(D) EDTA complexometric titration with Eriochrome Black T indicator

2018

21. Which physicochemical mechanism describes the process by which a detergent reduces the interfacial tension between the cleaning solution and the soiled surface, allowing the liquid to spread?
(A) Emulsification
(B) Wetting
(C) Peptization
(D) Sequestration

2017

22. During the detergency process, what is the specific role of emulsification?
(A) Chemically breaking down proteins into smaller, highly soluble peptide chains
(B) Rapidly dissolving stubborn mineral scales directly from the equipment surface
(C) Suspending liquid fat droplets in the solution to prevent redeposition
(D) Completely killing vegetative bacterial cells deeply embedded in the soil matrix

2010

23. What does the term 'peptization' refer to in the context of cleaning dairy equipment?
(A) The physical scrubbing of equipment surfaces utilizing high-velocity turbulent fluid flow
(B) The specific chemical process of rendering scale-forming water hardness ions inactive
(C) The saponification reaction occurring between alkaline agents and free fatty acids
(D) The chemical breakdown and dispersion of proteins into colloidal solutions

2017

24. Which detergent property ensures that loosened soil particles remain suspended in the cleaning solution until they can be rinsed away?
(A) Dispersion
(B) Saponification
(C) Sequestration
(D) Wetting

2016

25. Match the detergency mechanism in List I with its corresponding definition in List II.
List I: (Detergency Mechanism)
P. Saponification
Q. Sequestration
R. Wetting
S. Emulsification
List II: (Definition)
1. Lowering surface tension for better liquid spreading
2. Suspension of immiscible liquid soils in the washing fluid
3. Binding of dissolved mineral ions into soluble

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vat walls
(C) They are strongly inhibited by hard water cations and tend to foam excessively during high-flow circulation
(D) They react chemically with primary casein proteins to formulate a highly bitter and intense off-flavor

2016
60. How does temperature generally affect the action of traditional iodine-based sanitizers?
(A) They require boiling temperatures to become activated
(B) They form explosive compounds when heated above 30 degrees Celsius
(C) They sublimate and lose iodine gas rapidly at temperatures above 45-50 degrees Celsius
(D) They become increasingly stable and more active at temperatures exceeding 80 degrees Celsius

2025
61. Peracetic acid (PAA) is widely recognized as an advanced sanitizer in the dairy industry. What makes it highly environmentally friendly?
(A) It incorporates nitrogen gas into the atmosphere upon breakdown
(B) It synthesizes naturally occurring soil bacteria
(C) It neutralizes acidic wastewater upon degradation
(D) It decomposes solely into acetic acid, oxygen, and water

2010
62. Which advanced sanitization technology relies on the in-situ generation of an unstable gas that is highly effective against biofilms and requires no final rinse?
(A) Quaternary ammonium application
(B) Acidified sodium chlorite
(C) Ozonation
(D) Iodophor fogging

2012
63. What is the primary limitation of applying Ultraviolet (UV) irradiation for sanitization in dairy processing?
(A) It consistently leaves behind a highly toxic and heavy chemical residue
(B) It only acts on line-of-sight surfaces, failing to penetrate opaque fluids
(C) It triggers rapid, immediate electrochemical oxidation of stainless steel surfaces
(D) It can function and operate effectively only when placed in a strict clinical vacuum

2014
64. Chlorine dioxide (ClO_2) is an advanced sanitizer. How does its efficacy compare to standard sodium hypochlorite in the presence of organic matter?
(A) Chlorine dioxide (ClO_2) is entirely and completely deactivated by even trace physical amounts of organic matter
(B) Chlorine dioxide rapidly binds to milk proteins, rendering its chemical behavior identical to standard hypochlorite
(C) Chlorine dioxide functions with high efficiency only when introduced and mixed directly into raw unpasteurized milk
(D) Chlorine dioxide is less affected by organic matter and does not form chloramines

2002
65. Consider the following statements regarding advanced sanitization technologies:
I. Peracetic acid maintains excellent efficacy even at low temperatures, making it ideal for cold CIP circuits.
II. Ozone generation requires significant electrical energy and specialized on-site equipment.
III. UV irradiation chemically alters the surface finish of stainless steel over time.
IV. Chlorine dioxide is typically delivered as a stable bulk liquid requiring no on-site mixing.
V. PAA acts primarily by generating reactive oxygen species that disrupt cell walls.
Which of the above statement(s) is/are correct?
(A) I, II, III and V
(B) I, II and V
(C) II, III, IV and V
(D) I, III and IV

NODIA

2015
66. At what specific wavelength is Ultraviolet (UV) light most lethal to microorganisms (the peak of the germicidal action curve)?
(A) 150 nm
(B) 254 nm
(C) 365 nm
(D) 420 nm

2009
67. Which of the following sanitizers provides the most robust efficacy against bacterial spores (such as Bacillus species) at ambient temperatures?
(A) Peracetic acid at high concentrations

2006

34. Which of the following is a common disadvantage of using complex polyphosphates (like sodium tripolyphosphate) in dairy detergents?
(A) They rapidly degrade, corrode, and pit highly polished stainless steel surfaces
(B) They generate unstable, highly explosive gas mixtures when dissolved in hard water
(C) They revert to orthophosphates at high temperatures, losing sequestering power
(D) They permanently neutralize the natural saponification capabilities of sodium hydroxide

2009

35. Why is sodium carbonate (soda ash) typically considered a weaker component compared to sodium hydroxide in dairy detergency?
(A) It has lower buffering capacity and active alkalinity for heavy soil removal
(B) It triggers a rapid chemical reaction causing immediate oxidation of the organic soil
(C) It releases highly hazardous, toxic gases when dissolved in extremely warm water
(D) It actively binds to milk proteins, resulting in the creation of a secondary fouling layer

2023

36. Which chelating agent is most commonly included in alkaline detergents due to its high stability and effectiveness at sequestering calcium at high pH levels?
(A) Concentrated hydrochloric mineral acid
(B) Standard industrial sodium hypochlorite
(C) Anhydrous cleaning isopropyl alcohol
(D) Ethylenediaminetetraacetic acid (EDTA)

2016

37. What is the typical operational concentration range of caustic soda (NaOH) used in standard dairy CIP wash solutions?
(A) 0.05 to 0.1 percent
(B) 0.5 to 1.5 percent
(C) 5.0 to 10.0 percent
(D) 15.0 to 20.0 percent

2021

38. Which component is often added to caustic-based CIP solutions to enhance wetting and soil penetration without generating excessive foam?
(A) High-foaming anionic surfactants
(B) Cationic sanitizing chemicals
(C) Low-foaming nonionic surfactants
(D) Strong mineral oxidizing acids

2003

39. In highly alkaline detergency, what chemical transformation occurs to the free fatty acids present in milk soil?
(A) They undergo chemical polymerization into highly resilient hard films
(B) They are rapidly reduced to highly volatile, foul-smelling aldehydes
(C) They precipitate out as completely insoluble calcium mineral complexes
(D) They are converted into water-soluble sodium soaps

2024

40. Which property of sodium hydroxide makes it hazardous and requires strict safety protocols during handling in dairy plants?
(A) Extreme corrosiveness causing severe chemical burns
(B) High flammability risk under typical processing temperatures
(C) Strong oxidizing potential resulting in the release of toxic chlorine gas
(D) Spontaneous combustion risk when brought into direct contact with ambient air

2023

41. What is the primary objective of the acid wash cycle in a dairy Cleaning-In-Place (CIP) system?
(A) Saponification and breakdown of heavy milk lipid residues
(B) Removal of mineral deposits and alkaline residues
(C) Complete emulsification of highly denatured whey proteins
(D) Terminal sterilization of the entire processing environment

2013

42. Which inorganic acid is most universally utilized in dairy CIP applications due to its excellent mineral dissolving capability and compatibility with stainless steel?
(A) Hydrochloric acid
(B) Nitric acid
(C) Sulfuric acid
(D) Hydrofluoric acid

2006

43. Why is hydrochloric acid generally avoided in the routine cleaning of dairy equipment?
(A) It promotes severe pitting and stress corrosion in stainless steel
(B) It is chemically too weak to dissolve stubborn calcium-rich milk stone
(C) It reacts immediately with milk fat to

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2022

75. Which sensor is absolutely critical in the return line of a recovery CIP system to automatically determine the concentration of the circulating detergent?
(A) Conductivity transmitter
(B) Ultrasonic flow transmitter
(C) Optical turbidity sensor
(D) Static pressure transducer

2016

76. In standard CIP cycle sequencing for heated surfaces (like pasteurizers), what follows the alkaline wash and intermediate rinse?
(A) A secondary alkaline wash
(B) A sanitization cycle using chlorine
(C) An acid wash to remove mineral scale
(D) A steam sterilization cycle

2017

77. What is a "dead leg" in the context of dairy CIP engineering?
(A) The final waste discharge pipe that leads directly to the primary effluent treatment plant
(B) The secondary backup standby pump utilized exclusively during sudden emergency mechanical breakdowns
(C) A specialized chemical injection fitting designed to introduce highly concentrated nitric acid
(D) A pipe section where fluid velocity drops to zero, allowing bacterial harborage

2023

78. Match the CIP component in List I with its primary function in List II.
List I: (CIP Component)
P. CIP Supply Pump
Q. Scavenge (Return) Pump
R. Conductivity Probe
S. Shell and Tube Heat Exchanger
List II: (Primary Function)
1. Maintains solution temperature during circulation
2. Drives the cleaning fluid through the processing lines and spray balls
3. Pulls fluid back from tanks to prevent pooling
4. Monitors detergent strength for automated dosing
(A) P-2, Q-3, R-4, S-1
(B) P-3, Q-2, R-1, S-4
(C) P-4, Q-1, R-3, S-2
(D) P-2, Q-1, R-4, S-3

2003

79. When cleaning large dairy storage tanks (silos) via CIP, how is the cleaning solution typically distributed to ensure coverage of all internal surfaces?
(A) By slowly flooding the entire tank capacity with hot detergent until it overflows
(B) By using spray balls or rotary jet heads at the top of the vessel
(C) By utilizing a high-pressure manual washing hose carefully inserted through the manway
(D) By rapidly spinning the entire storage tank on a heavy external motorized chassis axis

2016

80. Why is the pre-rinse fluid typically routed straight to the drain rather than being recovered in a multi-use CIP system?
(A) It contains extremely high, hazardous residual levels of active chemical sanitizers
(B) It is thermally too hot to be safely managed or stored inside standard recovery tanks
(C) It instantly forms insoluble precipitates when blended directly with clean processing water
(D) It contains high levels of soil and organic matter that would deplete detergent strength

2002

81. The TACT principles govern the optimization of CIP parameters. What does the acronym TACT stand for?
(A) Time, Action, Concentration, Temperature
(B) Temperature, Agitation, Concentration, Time
(C) Turbulence, Alkalinity, Causticity, Temperature
(D) Thermal, Acidic, Cleaning, Titration

NODIA

2013

82. In pipeline CIP optimization, fluid dynamics play a crucial role under the 'Action' parameter. What is the minimum standard fluid velocity generally required to achieve the necessary turbulent flow for effective pipe cleaning?
(A) 0.5 meters per second
(B) 1.5 meters per second
(C) 5.0 meters per second
(D) 10.0 meters per second

2002

83. The effectiveness of mechanical cleaning action in a pipe is correlated with turbulent flow. Which dimensionless number must typically exceed 4000 (and ideally be much higher) to ensure adequate turbulence in a dairy CIP circuit?

(C) II and IV
(D) I, II and IV

2011

51. What is the fundamental mechanism of action by which chlorine-based sanitizers destroy bacterial cells?
(A) Oxidation of structural proteins and vital cellular enzymes
(B) Competitive biological inhibition of intracellular lactose synthesis
(C) Direct physical disruption of the cell membrane through surfactant action
(D) Reversible chemical binding to bacterial ribosomes, halting protein assembly

2015

52. The germicidal efficacy of hypochlorite sanitizers is highly dependent on pH. At which pH range is the concentration of the active antimicrobial species, hypochlorous acid (HOCl), optimized for safe plant use?
(A) Strongly and highly alkaline (pH 10-12)
(B) Dangerously and strongly acidic (pH 1-3)
(C) Moderately to mildly alkaline (pH 8-9)
(D) Slightly acidic to neutral (pH 5.5-7.0)

2014

53. What is a defining characteristic of iodophor sanitizers used in the dairy industry?
(A) They exhibit extreme chemical sensitivity when exposed to hard water minerals
(B) They release elemental iodine slowly from a surfactant complex
(C) They are completely and utterly ineffective against highly resistant fungal spores
(D) They leave a highly toxic chemical residue requiring a mandatory final rinse

2015

54. Quaternary Ammonium Compounds (QACs) are extensively used for environmental sanitization. What is their primary mode of antimicrobial action?
(A) They act as highly powerful chemical oxidizers that directly destroy bacterial DNA
(B) They drastically lower the intracellular pH, permanently deactivating vital metabolic enzymes
(C) Cationic surfactants that disrupt cell membranes, causing leakage and death
(D) They rapidly dehydrate the vegetative bacterial cell through severe hypertonic osmotic pressure

2011

55. Which sanitizer is most notorious for causing corrosion on stainless steel if left in contact for extended periods or used at excessive concentrations?
(A) Iodophors
(B) Quaternary Ammonium Compounds
(C) Peracetic acid
(D) Sodium hypochlorite

2023

56. Why are QACs typically preferred over chlorine for the sanitization of dairy plant floors and walls?
(A) QACs leave a residual antimicrobial film, whereas chlorine dissipates quickly
(B) QACs dry and evaporate extremely rapidly, leaving the concrete floor completely dry
(C) QACs demonstrate powerful and highly effective action against active bacterial spores
(D) QACs completely dissolve and emulsify heavy, accumulated organic dairy soil build-up

2016

57. What visual indicator helps operators determine if an iodophor sanitizing solution is still active and at an effective concentration?
(A) The solution produces a high, stable foam head
(B) The solution maintains a distinct amber/yellow color
(C) The solution turns a deep blue color
(D) The solution becomes completely colorless and transparent

2012

58. Which of the following conditions drastically reduces the efficacy of chlorine-based sanitizers in dairy applications?
(A) The routine use of soft demineralized water
(B) The presence of high organic loads
(C) Operating at thermal temperatures below 60 degrees Celsius
(D) Mixing directly with trace residual amounts of nitric acid

2021

59. What is a major disadvantage of using Quaternary Ammonium Compounds (QACs) as a terminal sanitizer inside cheese vats?
(A) They inhibit starter cultures at trace levels, causing manufacturing failure
(B) They promote rapid corrosion and severe localized pitting of the stainless steel cheese

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(A) Parts are disassembled, placed in a specialized tank, and cleaned via agitated flow
(B) Assembly lines are cleaned while remaining fully intact utilizing high-pressure steam
(C) The entire plant is shut down and cleaned manually using heavy-duty scrub brushes
(D) Equipment is packaged and cleaned by an external specialty contractor off-premises

2001

92. Which types of dairy equipment components are most routinely subjected to COP protocols?
(A) Large, high-volume atmospheric bulk raw milk storage silos
(B) Lengthy, fully welded continuous overhead transport pipelines
(C) Dismantlable parts, filler valves, and pump impellers
(D) Fully welded and sealed multi-section plate heat exchangers

2003

93. How is the mechanical action (scrubbing effect) primarily achieved in a COP parts washer tank?
(A) Through direct, continuous manual physical scrubbing by a trained operator using stiff wire brushes
(B) By rapidly rotating the entire structural wash tank at high rotational speeds on a heavy motor spindle
(C) By boiling the washing water to generate highly violent, expanding steam bubbles throughout the bath
(D) By using high-velocity jets or impellers that create rolling turbulence

2006

94. What is the most critical safety requirement for personnel executing manual cleaning operations in a dairy plant?
(A) Wearing sterile disposable surgical goggles combined with protective high-traction rubber boots
(B) Ensuring all cleaning operators have successfully obtained a master's degree in chemical science
(C) Using Personal Protective Equipment such as chemical gloves, goggles, and aprons
(D) Working exclusively inside complete and total darkness to spot highly fluorescent organic soils

2022

95. When manually cleaning sensitive dairy components (e.g., plug valves, delicate gaskets), which practice must be strictly avoided?
(A) Using lukewarm potable water for the initial pre-rinsing cycle
(B) Using abrasive tools like steel wool or metallic scrapers
(C) Using mild, high-foaming organic acid manual cleaning detergents
(D) Allowing clean, rinsed parts to air dry naturally on a sanitary rack

2001

96. Why is foaming specifically desired in manual cleaning detergents but avoided in standard CIP detergents?
(A) Foam reacts chemically with free milk fat molecules to generate and release a highly pleasant citrus odor
(B) Foam acts as a high-friction physical abrasive pad to rapidly scratch and scrub the stainless surface clean
(C) Foam instantly and completely neutralizes all vegetative bacterial cells immediately upon physical contact
(D) Foam increases chemical contact time on vertical surfaces and visually indicates coverage

2011

97. In COP tank operations, how should dismantled pipe sections and long tubular fittings be loaded into the wash trough?
(A) Parallel to the fluid jet flow to allow solution to pass completely through them
(B) Placed vertically, sticking far out of the water level to prevent physical sediment deposition
(C) Oriented perpendicular to the flow to block the high-velocity jets and create external splash
(D) Tightly bundled together in dense physical configurations and secured with heavy stainless wire

NODIA

2002

98. Given below are two statements, one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): Complex equipment like older positive displacement pumps and manual valves require daily tear-down and manual cleaning or COP.
Reason (R): These components possess tight clearances and crevices that do not receive

methane gas rather than producing new cell mass.

Which of the following is correct?

(A) Both A and R are true and R is the correct explanation of A
(B) Both A and R are true but R is not the correct explanation of A
(C) A is true but R is false
(D) A is false but R is true

2015

151. What specific structural formation inside a UASB reactor allows for the retention of high concentrations of active biomass without the need for a solid media support?

(A) Submerged fine bubble air diffusers
(B) Settleable anaerobic sludge granules
(C) Active rotating biological contactors
(D) High-pressure reverse osmosis membranes

2007

152. In an aerobic treatment plant, a condition known as "sludge bulking" can occur, severely impairing the clarifier. What is the typical biological cause?

(A) Complete and sudden die-off of all active microbial life due to extremely low pH
(B) Rapid overgrowth of methanogenic archaea species within the aerobic aeration tank
(C) Proliferation of filamentous bacteria preventing sludge floc compaction
(D) Chronic accumulation of toxic heavy metals and inorganic salts in the biomass

2005

153. What vital parameter must be continuously monitored and maintained in the aeration tank of an ASP to ensure efficient bacterial respiration?

(A) Total dissolved solids and inorganic mineral salinity
(B) Outflow biogas pressure and methane concentration levels
(C) Free chlorine residual and downstream chemical sanitizer
(D) Dissolved Oxygen (DO) levels between 1.5 and 2.0 mg/L

2016

154. Following biological wastewater treatment, "Waste Activated Sludge (WAS)" must be managed. What is the initial step in sludge processing?

(A) Sludge thickening to reduce water content and volume
(B) Direct land application of raw untreated liquid waste
(C) Thermal incineration at ultra-high combustion temperatures
(D) High-pressure deep well geological injection methods

2002

155. Which mechanical device is frequently used in dairy plants for the rapid dewatering of biological sludge, utilizing centrifugal force?

(A) Filter press
(B) Decanter centrifuge
(C) Gravity thickener
(D) Sand drying bed

2013

156. What is the primary purpose of applying a polymer coagulant to the sludge before it enters the dewatering equipment?

(A) To reduce the viability of active pathogenic bacteria within the biological mass
(B) To enhance flocculation for easier separation of water and solids
(C) To increase the overall nutritional value of the final sludge
(D) To change the physical color of the sludge to facilitate easier monitoring

2021

157. Once dairy sludge is adequately dewatered and stabilized, what is a highly common and ecologically sound method of final valorization?

(A) Land application as an organic soil conditioner and fertilizer
(B) Direct deep ocean dumping and marine disposal in designated zones
(C) Mixing it directly into high-energy livestock feed formulations
(D) Processing and exporting it as regulated hazardous chemical waste

2004

158. Solid waste generated from sweeping the dairy plant floors often contains plastic wrappers, caps, and hairnets. How must this be managed?

(A) Flushed directly down the floor drains and routed to the primary effluent plant
(B) Melted down and thermally destroyed inside the high-temperature plant boilers
(C) Segregated into dry waste bins and sent to a landfill or recycling facility
(D) Chemically dissolved using concentrated nitric acid solutions in cleaning loops

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(A) Sanitary Tri-Clamp fittings with flush elastomeric gaskets
(B) Standard heavy-duty bolted flanges equipped with flat paper gaskets
(C) Industrial-grade PVC glued slip joints using solvent welding cement
(D) Exposed, non-sanitary threaded union connections with metal seats

2008

108. In sanitary design, what is the primary structural requirement for the internal corners of processing tanks?
(A) They must be constructed to be acutely angled to maximize volumetric storage capacity
(B) They must be physically bolted and tightly sealed using heavy-duty chemical silicone caulking
(C) They must be continuously welded, ground smooth, and radiused
(D) They must be internally lined with thick, heavy-duty food-grade plastic protective inserts

2012

109. Which of the following elastomer materials is highly resistant to both dairy fats and common CIP chemicals, making it a standard choice for sanitary gaskets?
(A) High-elasticity natural rubber polymers
(B) Standard untreated organic pressed cork
(C) Reinforced industrial-grade cardboard
(D) Ethylene Propylene Diene Monomer (EPDM)

2016

110. How does a sanitary "mix-proof" valve ensure that raw CIP chemicals do not contaminate the pasteurized product flowing in an adjacent line?
(A) By relying strictly on a single, extremely thick high-density rubber gasket to block all fluid flow
(B) By automatically injecting neutralizing counter-chemicals immediately before they cross the physical valve
(C) By using an air gap and double-seat layout with an atmospheric vent
(D) By utilizing integrated liquid nitrogen channels to instantly freeze the flowing fluid at the barrier

2004

111. What is the primary operational advantage of using enzyme-based bio-detergents for cleaning dairy equipment compared to traditional alkaline/acid cleaners?
(A) They act completely instantaneously upon surface contact, requiring zero chemical exposure or contact time
(B) They work at neutral pH and lower temperatures, saving energy and hazards
(C) They completely and permanently sterilize the equipment, totally eliminating the future need for chemical sanitizers
(D) They automatically induce a highly polished, protective structural shine on the external chassis of the equipment

2023

112. Which specific class of enzymes is formulated into bio-detergents to specifically target and degrade denatured whey protein films?
(A) Lipases
(B) Amylases
(C) Cellulases
(D) Proteases

2025

113. When addressing stubborn lipid (fat) deposits in cold milk lines using bio-detergents, which enzyme is essential?
(A) Lipase
(B) Protease
(C) Pectinase
(D) Lactase

2024

114. Why are traditional bio-detergents often inadequate for cleaning high-temperature thermal processing equipment (like pasteurizers)?
(A) The active enzymatic proteins consume the remaining trace lactose molecules at an chemically rapid, uncontrollable rate
(B) The engineered enzymes mutate viable pathogenic bacteria present inside milk stone, generating resistant strains
(C) Mineral components (calcium phosphates) in milk stone cannot be degraded by proteases or lipases
(D) The enzymes undergo highly violent, hazardous exothermic physical reactions upon making contact with mineral scale

2009

115. Consider the following statements regarding the eradication of biofilms using bio-detergents:
I. Biofilms protect embedded bacteria through an Extracellular Polymeric Substance (EPS) matrix.

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adequate turbulent flow during automated CIP operations.
Which of the following is correct?
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2013
99. Which chemical agent is typically avoided in COP tanks due to the risk of off-gassing and inhalation hazards to operators working nearby?
(A) Hot, highly concentrated nitric acid
(B) Mild, high-foaming alkaline agents
(C) Neutral-pH bio-active enzyme cleaners
(D) Low-foaming non-ionic surfactants

2024
100. During manual brush cleaning of a vat, what is the best practice regarding the sequence of cleaning?
(A) Clean the surrounding floor area first, followed by scrubbing the vat interior
(B) Clean from the physical bottom up to guarantee the detergent fluid does not run down
(C) Scrub the entire surface randomly to ensure all hidden geometric angles are covered
(D) Clean from top to bottom, preventing re-soiling of cleaned areas

2018
101. In the sanitary design of dairy equipment, what does the R_a value measure?
(A) The relative chemical acidity of the finished metal surface
(B) The arithmetical mean roughness of the surface profile
(C) The maximum rotational acceleration of the sanitizing pumps
(D) The radioactive isotope absorbance rate of the stainless steel

2023
102. What is the globally accepted maximum R_a value for product-contact surfaces in sanitary dairy equipment to effectively prevent bacterial adhesion?
(A) 0.8 micrometers
(B) 3.2 micrometers
(C) 5.0 micrometers
(D) 10.0 micrometers

2007
103. Which grade of stainless steel is most commonly specified for standard sanitary dairy product-contact surfaces due to its excellent corrosion resistance and polishability?
(A) AISI 410
(B) AISI 430
(C) AISI 1020
(D) AISI 304

2010
104. For processing environments handling highly corrosive fluids (e.g., high chloride solutions or strong acids), which grade of stainless steel is preferred due to the addition of molybdenum?
(A) AISI 316
(B) AISI 304
(C) AISI 440C
(D) Carbon steel

NODIA

2005
105. Consider the following statements regarding the sanitary design of dairy equipment:
I. Equipment must be self-draining to prevent pooling of liquids.
II. Hollow bodies or enclosed frames must be hermetically sealed to prevent internal bacterial harborage.
III. Sharp internal 90-degree corners are preferred to increase fluid turbulence.
IV. Dead legs in piping should ideally be eliminated, or kept to a length not exceeding two times the pipe diameter.
Which of the above statement(s) is/are correct?
(A) I, II and IV
(B) I, II, III and IV
(C) I and IV
(D) II, III and IV

2008
106. Why are threaded connections (e.g., standard pipe threads) strictly prohibited in product-contact areas of sanitary dairy piping?
(A) They are highly complex and extremely expensive to manufacture at scale
(B) The thread roots harbor soil and bacteria unreachable by CIP
(C) They absolutely cannot withstand the high operating pressure of homogenizers
(D) They trigger rapid galvanic corrosion when contacted by aggressive CIP chemicals

2012
107. What type of connection is most universally used in sanitary dairy pipelines to ensure a smooth, crevice-free internal transition?

2006
123. Which component of dairy wastewater is the most significant contributor to elevated BOD levels?
(A) Dilute nitric acid from CIP
(B) Milk fat and lactose from product losses
(C) Suspended sand particles from floor sweepings
(D) Dissolved sodium hydroxide

2011
124. What does the parameter "FOG" stand for in the context of dairy wastewater characterization?
(A) Floating Organic Gradients
(B) Fat, Oil, and Grease
(C) Flocculated Oxygen Groups
(D) Filtered Organic Grams

2011
125. Why are extreme fluctuations in effluent pH (ranging from pH 2 to 12) a common characteristic of dairy wastewater?
(A) Due to batch discharges of strongly alkaline and acidic CIP solutions
(B) Due to the natural fermentation of residual lactose into lactic acid
(C) Due to the routine dumping of active starter cultures directly into drains
(D) Due to seasonal shifts and variations in the raw milk mineral composition

2017
126. Total Suspended Solids (TSS) in dairy effluent primarily consist of which materials?
(A) High concentrations of dissolved lactose sugars and sodium ions
(B) Soluble whey proteins and non-protein nitrogen fractions
(C) Coagulated proteins, cheese curd fines, and insoluble fats
(D) Dissolved atmospheric gases and volatile organic compounds

2022
127. Which analytical test utilizes potassium dichromate as a strong oxidizing agent under acidic conditions to evaluate wastewater strength?
(A) BOD5 test
(B) Kjeldahl Nitrogen test
(C) Gravimetric TSS test
(D) COD test

2018
128. What is the typical BOD5 of whole raw milk?
(A) Approx. 100 mg/L
(B) Approx. 1,000 mg/L
(C) Approx. 100,000 mg/L
(D) Approx. 1,000,000 mg/L

2011
129. Why is high FOG content particularly problematic for standard biological effluent treatment systems if not removed during primary treatment?
(A) It causes the biological effluent to become highly acidic and corrosive
(B) It coats biological sludge, inhibiting oxygen transfer and settleability
(C) It causes immediate precipitation of calcium phosphate scale on aeration piping
(D) It selectively promotes the growth of methanogenic archaea under aerobic conditions

2006
130. Which of the following sequences represents the standard analytical procedure for determining Total Suspended Solids (TSS)?
(A) Filter sample, dry at 500 degrees Celsius, weigh ash
(B) Weigh filter paper, dry at 103-105 degrees Celsius, filter sample, weigh again
(C) Dry sample in crucible at 500 degrees Celsius, dissolve in acid, weigh residue
(D) Weigh filter paper, filter sample, dry filter paper at 103-105 degrees Celsius, weigh again

2014
131. In many jurisdictions, what is the generally acceptable regulatory discharge limit for BOD in treated dairy effluent directed into inland surface waters?
(A) Less than 30 mg/L
(B) Less than 500 mg/L
(C) Less than 1000 mg/L
(D) Less than 5000 mg/L

2016
132. What is the fundamental purpose of an equalization basin in a dairy effluent treatment plant?
(A) To biologically digest and break down the complex organic matter
(B) To physically filter out microscopic suspended and colloidal solids
(C) To buffer extreme variations in flow rate, pH, and organic load
(D) To cool high-temperature effluent streams to ambient temperatures

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II. Standard chlorine sanitizers easily penetrate and completely dissolve mature EPS matrices.
III. Specific enzyme blends can degrade the EPS matrix, exposing the bacteria to subsequent sanitization.
IV. Bio-detergents must generally be used at lower temperatures than boiling caustic to avoid denaturing the active enzymes.
V. Proteases alone are sufficient to remove all mineral deposits in a biofilm.

Which of the above statement(s) is/are INCORRECT?
(A) II and V
(B) I, II and IV
(C) III and IV
(D) I, III and V

2021
116. What is a major vulnerability of enzyme-based cleaning solutions when implemented in a standard dairy CIP protocol?
(A) They cause severe corrosion and pitting in high-grade 316 stainless steel alloys
(B) They generate uncontrollable amounts of toxic chlorine gas when exposed to acids
(C) They are easily deactivated by the extreme pH and high temperatures of traditional CIP
(D) They undergo instant solidification and precipitation upon contacting raw milk

2006
117. How do proteases facilitate the removal of proteinaceous soil?
(A) By hydrolyzing peptide bonds, breaking insoluble proteins into soluble peptides
(B) By emulsifying hydrophobic protein residues into stable liquid micelles in solution
(C) By acting as specific chelating agents to bind calcium and destabilize the matrix
(D) By physically oxidizing organic protein structures directly into carbon dioxide gas

2004
118. In the context of dairy biofilms, what is the primary composition of the Extracellular Polymeric Substance (EPS) that enzymes attempt to break down?
(A) Triglycerides and free fatty acid emulsions
(B) Crystallized lactose and amorphous sugar residues
(C) Calcium carbonate and inorganic mineral scale networks
(D) Polysaccharides, proteins, and extracellular DNA

2024
119. What is a typical operational temperature range to maximize the catalytic activity of most commercial bio-detergents used in dairy plants?
(A) 0 to 10 degrees Celsius
(B) 40 to 50 degrees Celsius
(C) 85 to 95 degrees Celsius
(D) 120 to 130 degrees Celsius

2004
120. Match the enzymatic agent in List I with its target soil substrate in List II.

List I: (Enzymatic Agent)
P. Protease
Q. Lipase
R. Amylase
S. Lactase

List II: (Target Soil Substrate)
1. Hydrolyzes milk sugar (rarely used in detergency, but relevant in dairy)
2. Degrades starch residues (often found in flavored/formulated dairy products)
3. Cleaves peptide bonds in denatured beta-lactoglobulin
4. Hydrolyzes triglycerides into glycerol and free fatty acids

(A) P-4, Q-3, R-1, S-2
(B) P-3, Q-1, R-4, S-2
(C) P-3, Q-4, R-2, S-1
(D) P-2, Q-4, R-3, S-1

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2004
121. Which parameter measures the total amount of oxygen required by microorganisms to biologically degrade the organic matter present in dairy wastewater?
(A) Chemical Oxygen Demand (COD)
(B) Total Organic Carbon (TOC)
(C) Dissolved Oxygen (DO)
(D) Biochemical Oxygen Demand (BOD)

2022
122. In dairy effluents, the COD value is generally higher than the BOD value. What is the primary reason for this?
(A) COD measures both biodegradable and chemically oxidizable organic substances
(B) BOD is limited to measuring readily biodegradable organic matter
(C) COD primarily measures dissolved inorganic salts and mineral scale
(D) Dairy effluent contains vast amounts of heavy metals that interfere with bioassays

(D) They inadvertently add harmful heavy metals to the effluent stream

2025

142. During the operation of an equalization basin, why is it typically necessary to install submerged mixers or diffuse air into the tank?
(A) To facilitate the stripping of volatile organic carbon into the atmosphere
(B) To promote anaerobic fermentation of lactose before biological treatment
(C) To prevent solids from settling and maintain aerobic conditions to avoid odors
(D) To achieve complete thermal sterilization of the raw effluent

2019

143. Which biological treatment process utilizes a suspended growth of aerobic microorganisms to degrade the organic matter in wastewater?
(A) Trickling filter
(B) Upflow Anaerobic Sludge Blanket (UASB)
(C) Dissolved Air Flotation
(D) Activated Sludge Process (ASP)

2013

144. In the Activated Sludge Process, what is the purpose of the secondary clarifier?
(A) To vigorously aerate the wastewater to support microbial respiration
(B) To introduce chemical disinfectants to reduce pathogenic load
(C) To separate active biomass from treated water via gravity settling
(D) To physically screen out residual large plastic debris and large curds

2013

145. What does the term "Return Activated Sludge (RAS)" refer to in an aerobic treatment plant?
(A) The inactive solid sludge fraction that is permanently sent to the local landfill
(B) Settled biomass returned to the aeration tank to maintain microbial levels
(C) The sludge skimmed from the DAF unit that is safely sent back to the plant floor
(D) The dead bacterial mass that must be heavily chlorinated prior to final discharge

2024

146. How does a Trickling Filter differ primarily from an Activated Sludge Process?
(A) It relies entirely on anaerobic bacteria rather than the traditional suspended aerobic bacteria
(B) It operates under continuous high pressure inside a completely sealed and pressurized tank system
(C) It utilizes advanced chemical oxidation pathways rather than standard biological degradation
(D) It is an attached growth biofilm process on solid media rather than a suspended growth process

2009

147. Which technology is characterized as a high-rate anaerobic wastewater treatment process perfectly suited for high-strength dairy effluents like cheese whey?
(A) Upflow Anaerobic Sludge Blanket (UASB) reactor
(B) Suspended-growth aerobic Activated Sludge Process
(C) Extended aeration shallow basin Oxidation Ditch
(D) Surface aerated biological Aerated Lagoon system

2003

148. What is a major valuable by-product generated from the UASB reactor during the degradation of organic matter?
(A) High-purity industrial grade oxygen gas
(B) Concentrated high-purity organic lactic acid
(C) Biogas composed of methane and carbon dioxide
(D) Purified edible whey protein isolate powder

2001

149. Why is anaerobic treatment often followed by a polishing aerobic step in comprehensive dairy wastewater treatment?
(A) Anaerobic systems cannot achieve the low BOD levels needed for final discharge
(B) Downstream aerobic steps are strictly required to produce clean methane biogas
(C) Anaerobic effluent contains dissolved sulfides and volatile fatty acids that must be oxidized
(D) The aerobic step is needed to add beneficial dissolved solids back to the water

2021

150. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): Anaerobic wastewater treatment (like UASB) produces significantly less excess sludge compared to aerobic processes (like ASP).
Reason (R): Anaerobic bacteria utilize a large portion of the organic carbon to synthesize

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2015

133. How does a simple gravity fat trap function to remove FOG from dairy wastewater?
(A) It slows flow, allowing less dense fats to float and be skimmed off
(B) It utilizes heavy chemical coagulants to sink fat residues to the bottom
(C) It forces water under high pressure through microscopic membrane pores
(D) It introduces specialized digestive enzymes to dissolve fat instantaneously

2007

134. What does the acronym DAF stand for in primary wastewater treatment?
(A) Direct Acid Filtration
(B) Dynamic Aeration Flow
(C) Digested Anaerobic Floc
(D) Dissolved Air Flotation

2021

135. What is the mechanism of action in a Dissolved Air Flotation (DAF) unit?
(A) Heavy pressurized air bubbles drag heavy suspended solids down to the bottom
(B) Microscopic air bubbles attach to solids and fats, floating them to the surface
(C) High-pressure air blasts physically rupture and destroy organic cell walls
(D) Induced air flow creates a strong vacuum that draws solids out of the liquid

2024

136. To enhance the efficiency of a DAF unit in treating dairy wastewater, which chemicals are frequently added prior to flotation?
(A) Strong oxidizing sanitizers like sodium hypochlorite or chlorine gas
(B) Concentrated sodium hydroxide solutions to raise pH levels
(C) Coagulants like ferric chloride combined with polymeric flocculants
(D) Industrial-strength antimicrobial bio-detergents and enzyme blends

2008

137. Which physical screening device is typically installed at the very headworks of a dairy effluent plant to capture large debris (like packaging scraps and large curds)?
(A) High-pressure reverse osmosis membranes
(B) Deep granular activated carbon filters
(C) Pressurized multi-layer sand filter systems
(D) Rotary drum screens or static fine screens

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2018

138. Why is the pH of the effluent typically neutralized in the equalization tank rather than the biological aeration tank?
(A) Microorganisms are sensitive to pH shocks; pre-neutralization protects the biomass
(B) The biological aeration tank operates most efficiently at a highly alkaline pH of 12
(C) Neutralization reactions require rapid hydraulic mixing that would damage biological flocs
(D) Post-biological neutralization would lead to excessive precipitation of salts in the final clarifier

2018

139. What happens to the skimming layer (sludge) collected from the top of the DAF unit?
(A) It is discharged directly into the nearby municipal river system without treatment
(B) It is sent to a holding tank for dewatering or anaerobic digestion
(C) It is pumped back into clean CIP chemical storage tanks for immediate reuse
(D) It is sterilized and directly blended into liquid cattle feed

2012

140. Consider the following statements regarding primary treatment processes:
I. Fat traps effectively remove high concentrations of dissolved lactose.
II. Equalization basins help maintain a constant organic loading rate to downstream biological reactors.
III. Coagulants in a DAF system destabilize colloidal particles, allowing them to aggregate.
Which of the following represents the correct combination of accurate statements?
(A) I and II
(B) II and III
(C) I and III
(D) I, II and III

2016

141. What is the primary limitation of mechanical screens in the primary treatment of dairy effluent?
(A) They cannot remove soluble organic loads or emulsified fats
(B) They consume immense quantities of chemical polymer coagulants
(C) They are highly susceptible to structural destruction by UV light

2013

159. Which concept involves returning clean dairy packaging waste (like uncontaminated cardboard and LDPE films) into the manufacturing cycle?
(A) Anaerobic digestion
(B) Sludge thickening
(C) Bioremediation
(D) Upcycling and material recycling

2005

160. Consider the following statements regarding dairy solid waste and sludge management:
I. Dairy sludge from biological treatment is considered highly toxic hazardous waste.
II. Dewatering reduces the transportation cost of sludge significantly.
III. Composting is a viable stabilization method for mixed dairy sludge.
IV. Uncontaminated packaging waste can be valorized through recycling streams.
Which of the following represents the INCORRECT combination of statements?
(A) I and II
(B) I
(C) II and III
(D) I and IV

2010

161. Why is the anaerobic digestion of primary DAF sludge often more challenging than digesting secondary biological sludge?
(A) DAF sludge is composed primarily of heavy inorganic sand and grit
(B) DAF sludge contains high levels of long-chain fatty acids that inhibit methanogens
(C) DAF sludge has already undergone extensive anaerobic digestion during the flotation step
(D) Chemical coagulants in DAF sludge bind essential micronutrients, making them unavailable to anaerobic bacteria

2018

162. What thermal process involves the combustion of dried dairy sludge to generate heat, reducing the final waste volume to a small amount of ash?
(A) Pyrolysis
(B) Pasteurization
(C) Freeze-drying
(D) Incineration

2003

163. In a circular economy approach, how can whey, often a waste by-product in cheese plants, be directly valorized rather than sent to the wastewater plant?
(A) Filtered via ultrafiltration to recover Whey Protein Concentrate (WPC)
(B) Used directly as a highly acidic raw sanitizing and cleaning chemical
(C) Evaporated directly into safe, non-toxic atmospheric nitrogen gas
(D) Solidified into heavy concrete aggregate blocks for civil construction

2011

164. What is a "sludge drying bed"?
(A) A high-tech industrial microwave drying unit designed for rapid water evaporation
(B) A specialized high-temperature fluidized bed reactor utilized for chemical oxidation
(C) A low-tech sand filter bed where sludge dries via solar evaporation and drainage
(D) A continuous mechanical belt filter press operated inside the main utility building

2004

165. What is the fundamental objective of conducting an energy audit in a dairy processing plant?
(A) To systematically evaluate energy use, identify waste, and recommend savings
(B) To steadily increase the overall power consumption of motors for better performance
(C) To determine the exact number of administrative and manual employees in the plant
(D) To continuously monitor and record the biochemical and microbiological quality of raw milk

2016

166. In a typical liquid milk processing plant, which utility consumes the largest share of the total thermal energy?
(A) Electrical energy for compressed air generation
(B) Continuous fluorescent lighting in the warehouse
(C) Chilled water and glycol cooling systems
(D) Steam for pasteurization and CIP heating

2004

167. Which process engineering technology is heavily utilized in modern pasteurizers to drastically reduce steam consumption?
(A) Direct steam injection using high-pressure culinary grade steam
(B) Regenerative heat exchange between hot pasteurized and cold raw milk
(C) Standard batch vat heating systems operating with low-pressure jackets

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(D) High-frequency electromagnetic microwave heating elements in-line

2006

168. In evaluating boiler performance during an energy audit, what does the presence of high flue gas temperatures indicate?
(A) Exceptional overall boiler thermal efficiency and heat capture
(B) Perfect stoichiometric chemical combustion of the carbon fuel
(C) Poor heat transfer in the boiler, causing energy loss to the air
(D) Excessive moisture content present in the incoming coal or gas fuel

2012

169. What is a common and highly effective method for optimizing electrical load in dairy refrigeration systems?
(A) Running refrigeration compressors at maximum capacity continuously
(B) Removing high-efficiency thermal insulation from cold storage rooms
(C) Lowering evaporator temperatures far below the required baseline levels
(D) Installing Variable Frequency Drives (VFDs) on compressor motors

2015

170. During an electrical audit, an auditor identifies a poor "Power Factor" (e.g., 0.75). What is the standard corrective measure to improve this?
(A) Installing capacitor banks
(B) Increasing the voltage of the incoming supply
(C) Replacing all LED lights with incandescent bulbs
(D) Rewiring the entire plant with thinner cables

2001

171. Compressed air is one of the most expensive utilities in a dairy plant. What is the most common source of energy wastage in compressed air systems?
(A) Using air to operate pneumatic valves
(B) Undetected leaks in the distribution piping and fittings
(C) Filtering the air prior to usage
(D) Utilizing screw compressors instead of piston compressors

2003

172. In thermal auditing, why is the recovery and return of hot condensate back to the boiler highly recommended?
(A) Returned hot condensate acts as a natural sanitizer to clean inner boiler tubes
(B) It recovers high-temperature water, saving both fuel and water treatment chemicals
(C) Returning the condensate significantly increases the physical viscosity of steam
(D) Recirculating hot water prevents the boiler from producing dry superheated steam

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2015

173. What role does thermal insulation play in the energy efficiency of a dairy plant?
(A) It reduces heat loss from steam pipes and heat gain into chilled lines
(B) It significantly increases the electrical cooling load on refrigeration plants
(C) It allows the metal piping networks to conduct electrical currents more efficiently
(D) It facilitates rapid, unobstructed visual inspections of liquid pipe leaks

2010

174. Which key performance indicator (KPI) is typically calculated during a dairy energy audit to benchmark plant efficiency?
(A) Total liters of municipal water and clean well water consumed daily per employee
(B) Cumulative bacterial count of pasteurized product measured per kilowatt hour
(C) Specific Energy Consumption (e.g., energy consumed per liter of milk processed)
(D) Standard mass of chemical detergent and sanitizing agents utilized per year

2019

175. Match the utility auditing focus in List I with its corresponding energy-saving measure in List II.
List I: (Utility Auditing Focus)
P. Steam Systems
Q. Electrical Motors
R. Refrigeration
S. Compressed Air
List II: (Energy-Saving Measure)
1. Fixing distribution leaks and lowering generation pressure
2. Raising suction pressure and regular condenser cleaning
3. Installing Variable Frequency Drives (VFDs)
4. Repairing faulty steam traps and improving insulation
(A) P-2, Q-3, R-4, S-1
(B) P-4, Q-1, R-2, S-3
(C) P-1, Q-4, R-2, S-3
(D) P-4, Q-3, R-2, S-1

2005

176. What is the concept behind establishing a "water footprint" metric for a dairy plant?
(A) Measuring and recording the physical three-dimensional volumes of water storage tanks
(B) Mapping and tracing the flow of wastewater on the plant floor to prevent safety slips
(C) Quantifying total fresh water consumed directly and indirectly per unit of product
(D) Calculating and analyzing the heavy metal concentrations of deep borewell source water

2009

177. A well-optimized modern dairy plant typically strives for a specific water consumption ratio of:
(A) 0.1 liters of water per liter of milk processed
(B) 1 to 2 liters of water per liter of milk processed
(C) 10 to 15 liters of water per liter of milk processed
(D) 50 liters of water per liter of milk processed

2001

178. What is "Cow Water" in the context of dairy water conservation?
(A) High-purity treated drinking water provided directly to dairy cow herds in pastures
(B) Non-potable surface water used exclusively to wash down and clean open cow housing sheds
(C) Bulk raw milk shipments that have been deliberately and illegally adulterated with water
(D) Condensate reclaimed from milk or whey evaporation that can be reused in the plant

2012

179. Which of the following is a direct water conservation strategy implemented in multi-use CIP systems?
(A) Using recovered final clean rinse water as the pre-rinse for the next CIP cycle
(B) Discharging the hot final rinse water directly to the primary chemical effluent plant
(C) Demanding fresh, softened municipal water for every single individual phase of the cycle
(D) Bypassing the intermediate water rinse phase entirely to save processing cycle time

2018

180. Consider the following statements regarding water conservation in dairy plants:
I. Utilizing high-pressure, low-volume spray nozzles for floor cleaning significantly saves water compared to open hoses.
II. Cow water from evaporators is typically heavily contaminated and must go straight to the drain.
III. Automated CIP systems generally use less water than manual cleaning processes due to precise timing.
IV. Recovering boiler condensate reduces both thermal energy and fresh makeup water usage.
V. Dry sweeping of solid floor soils before hosing down is a critical water-saving GMP.
Which of the following represents the correct combination of accurate statements?
(A) I, II, III and V
(B) I, III, IV and V
(C) II, III, IV and V
(D) I, II, IV and V

2006

181. Why is the reuse of cooling tower blowdown water directly for product-contact CIP flushing generally prohibited?
(A) It contains high concentrations of chemical biocides, anti-scaling agents, and minerals
(B) It has lost thermal energy during evaporation and is far too cold to clean pipe fat deposits
(C) It instantly evaporates and flashes off upon contacting hot processing-grade stainless steel
(D) It lacks sufficient hydraulic pressure and velocity to reach and spin internal spray balls

2007

182. Which non-product contact application is a common destination for safely reusing RO-polished effluent water?
(A) Diluting the concentrated milk standardization tanks
(B) The final sanitizing rinse of a pasteurizer circuit
(C) Direct incorporation into fruit juice beverages
(D) Feeding the primary boilers or cooling tower makeup water

2018

183. How does the installation of "trigger nozzles" on manual washdown hoses contribute to water auditing and conservation?
(A) They significantly increase the maximum volumetric discharge flow rate tenfold at high pressure
(B) They shut off the flow automatically when dropped, preventing continuous water waste
(C) They heat the high-pressure water stream

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automatically inside the nozzle, requiring less volume
(D) They automatically inject concentrated liquid sodium hydroxide caustic directly into the stream

2002
184. In terms of water auditing, what is meant by conducting a "water mass balance"?
(A) Gravimetrically weighing the entire facility's physical water storage tanks using calibrated electronic load cells
(B) Chemically balancing and adjusting the pH levels of the raw municipal intake water to exactly 7.0 neutral
(C) Accounting for all incoming fresh water and balancing it against outgoing effluent, product, and losses
(D) Hydraulically ensuring the operating water pressure is completely identical across all individual processing plant sectors

2001
185. What potential microbiological risk is associated with over-recycling "Cow Water" without adequate treatment (like UV or RO)?
(A) Proliferation of pathogenic spore-formers in non-potable lines due to elevated storage temperatures
(B) Severe mineral scale deposition from trace calcium carryover in the condensate
(C) Immediate chemical corrosion of stainless steel evaporator tubes
(D) Trace organic carryover that can support rapid microbial growth in storage tanks

2017
186. Which phase of the CIP cycle traditionally consumes the highest volume of water and is thus the primary target for optimization?
(A) The rinsing phases (pre-rinse and final rinse)
(B) The heated chemical detergent wash phase
(C) The chemical or thermal sanitization phase
(D) The high-pressure filtered air blowdown phase

2004
187. What does the term Zero Liquid Discharge (ZLD) fundamentally mean in the context of a dairy processing plant?
(A) The plant produces absolutely no liquid fluid milk products, manufacturing only spray-dried milk powders
(B) All wastewater is purified and recycled, resulting in zero liquid leaving the site boundaries
(C) The factory completely stops using liquid water and performs all sanitation using pressurized dry air
(D) The processing plant discharges untreated chemical waste directly into the open ocean without pipelines

2022
188. Which core separation technology is typically employed as the primary purification step in a ZLD system to separate dissolved salts and trace organics from treated wastewater?
(A) Simple gravity sand filtration
(B) Reverse Osmosis (RO) membranes
(C) Dissolved Air Flotation (DAF)
(D) Centrifugal decanters

2017
189. In a ZLD scheme, what happens to the highly concentrated brine (reject stream) generated by the Reverse Osmosis process?
(A) It is sent to evaporators and crystallizers to reduce it to dry solids for disposal
(B) It is discharged directly and untreated into the municipal sewage or local river system
(C) It is formulated and mixed directly into standard finished dairy products to enhance flavor
(D) It is reclaimed and directly utilized as the primary heavy-duty alkaline cleaning detergent

2015
190. Arrange the following processes in the correct sequence for achieving Zero Liquid Discharge from raw dairy effluent.
I. Biological Treatment (UASB + ASP)
II. Reverse Osmosis (RO) membrane filtration
III. Multi-Effect Evaporation / Crystallization of brine
IV. Primary Treatment (Screening + DAF)
(A) I, IV, II, III
(B) IV, I, II, III
(C) II, I, IV, III
(D) IV, II, I, III

2004
191. What is a major economic barrier to implementing complete ZLD systems in older dairy processing facilities?
(A) It forces the entire processing plant to switch completely from automated CIP loops to manual cleaning
(B) Standard ZLD installations require the dairy

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plant to completely halt and cease operations for six months
(C) The recovered permeate water is of such high purity that it aggressively corrodes stainless steel alloys
(D) High capital costs and massive energy consumption required to evaporate the RO reject brine

2019
192. Aside from water, what other resources can theoretically be recovered and valorized from the ZLD evaporation process in a dairy plant?
(A) High-value, completely undenatured whey proteins and functional peptides
(B) Pure culinary-grade oxygen gas for packing and modified atmosphere storage
(C) Mixed inorganic salts that can be used in agricultural or industrial applications
(D) Pure concentrated crystalline lactose sugars for dairy formulation purposes

2023
193. The concept of "Zero Waste" in dairy production extends beyond wastewater. Which of the following best exemplifies a zero waste approach to solid organic by-products?
(A) Sending high-strength cheese whey directly to local municipal landfills
(B) Anaerobic digestion of organic sludge into biomethane to fuel plant boilers
(C) Incinerating all organic biological sludge inside furnaces without heat recovery
(D) Storing all generated solid plant wastes indefinitely inside underground silos

2005
194. Why is pretreatment (like ultrafiltration) absolutely necessary before feeding treated dairy effluent into the final ZLD Reverse Osmosis units?
(A) To significantly raise the overall temperature of the effluent stream close to the boiling point
(B) To dramatically increase the raw electrical conductivity of the water for optimal membrane flow
(C) To actively ensure that the incoming wastewater contains enough viable bacteria to seed membranes
(D) To remove suspended solids and macromolecules that would immediately foul the fine RO membranes

2016
195. What environmental driver is forcing many modern dairy plants located in arid regions to adopt ZLD technologies despite the high costs?
(A) Strict regulations on effluent discharge coupled with local freshwater scarcity
(B) The continuous availability of highly subsidized and plentiful fresh water supplies
(C) The corporate desire to steadily increase the cumulative carbon footprint of facilities
(D) The critical agricultural need to dilute heavy metal concentrations in surrounding soil

2011
196. When RO permeate (pure water) is recovered in a ZLD system, what issue must be addressed before it can be used in carbon steel boiler systems?
(A) Its extremely high electrical conductivity damages standard boiler electrode sensors
(B) It retains volatile organic compounds that cause severe boiler water foaming and carryover
(C) It lacks buffering capacity and dissolved minerals, making it highly corrosive and requiring chemical conditioning
(D) It has high concentrations of dissolved calcium ions that lead to rapid boiler scale formation

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2022
197. Which technology is emerging as a more energy-efficient alternative to traditional thermal evaporation for treating RO brine in ZLD processes?
(A) Forward Osmosis and Membrane Distillation
(B) Simple atmospheric sun drying ponds
(C) High-pressure homogenization
(D) Ultraviolet cracking

2007
198. In the context of dairy personnel management, what does the acronym GMP stand for?
(A) Good Management Protocol
(B) General Maintenance Procedure
(C) Guaranteed Microbial Protection
(D) Good Manufacturing Practices

2009
199. What is the fundamental purpose of implementing Good Hygiene Practices (GHP) among dairy plant personnel?
(A) To systematically ensure all floor employees and technicians arrive at work on time
(B) To prevent biological, chemical, or physical product contamination by workers

2016

228. Which component is frequently replaced during the sanitary maintenance of a spray dryer's high-pressure nozzle system to ensure proper atomization and prevent localized scorching?

(A) The massive air exhaust fan and associated high-power heavy electric motor assemblies

(B) The heavy-duty exterior acoustic and thermal insulation cladding surrounding the dryer chamber

(C) The internal swirl chambers and tungsten carbide orifice inserts that suffer high friction

(D) The main high-pressure steam or electrical air heating coil located inside the intake duct

2025

229. What defines a "sanitary weld" executed during the maintenance of a dairy pipeline?

(A) A smooth, full-penetration TIG weld flush with the inside pipe surface, free of crevices

(B) A standard structural manual weld executed exclusively by a technician wearing sanitary rubber gloves

(C) A traditional industrial arc weld heavily covered and sealed with white food-grade silicone paste

(D) A temporary pipeline repair executed using high-temperature sanitary adhesive wrap or tape

2019

230. During a post-maintenance validation check, what method is commonly used to ensure a tank or pipeline is completely free of organic residue before sanitization?

(A) Manually sniffing and smelling the interior of the closed tank to detect chemical odors

(B) Running clear hot water through the system and checking the exit water temperature manually

(C) Physically tapping the pipe with a metal hammer and listening closely to the auditory pitch

(D) ATP bioluminescence swabbing to instantly detect remaining organic cellular residue

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2015

207. How does the concept of 'zoning' assist personnel management in preventing cross-contamination?

(A) It strictly forces all factory employees and technical staff to work in one single unpartitioned room

(B) It sociologically categorizes and groups operating employees by their specific chronological age group

(C) It automatically determines the baseline hourly wage brackets of the engineering and maintenance staff

(D) It separates the plant into color-coded hygiene areas to restrict movement between raw and pasteurized zones

2018

208. What is the primary focus of regular health screening for food handlers in a dairy facility?

(A) Ensuring they have high physical fitness to lift heavy bags

(B) Checking their visual acuity to read small analog gauges

(C) Identifying asymptomatic pathogen carriers that can contaminate food

(D) Verifying their natural biological immunity to the common cold

2014

209. What is the core philosophy of a Preventive Maintenance (PM) system in a dairy plant?

(A) Waiting patiently for critical production equipment to break down completely before fixing it

(B) Performing scheduled maintenance, lubrication, and parts replacement to prevent breakdowns

(C) Intentionally running heavy processing machinery at double capacity to wear it out faster

(D) Outsourcing all maintenance work and repairs to the original equipment manufacturer post-failure

2003

210. Predictive maintenance goes a step further than preventive maintenance. Which technology is a hallmark of predictive maintenance for a high-speed dairy separator?

(A) Replacing rotating bearing assemblies every six months regardless of physical wear

(B) Painting the entire structural steel exterior of the high-speed separator annually

(C) Manually listening to the operational sounds of the running machine once a day

(D) Using vibration analysis sensors to detect early bearing wear before failure

2018

211. In condition monitoring of rotating machinery (like homogenizers and centrifugal pumps), what does an unexplained rise in operating temperature usually indicate?

(A) Friction caused by bearing wear, poor lubrication, or seal degradation

(B) The heavy-duty machine is currently operating at its absolute peak thermal efficiency

(C) The surrounding ambient temperature of the utility room has become too cold

(D) The incoming electrical supply line voltage is perfectly balanced and stable

2008

212. Which critical component of a high-pressure homogenizer requires strict preventive maintenance scheduling due to extreme mechanical stress?

(A) The external decorative brushed stainless steel cladding

(B) The low-pressure raw product intake and feed tank

(C) The homogenization valve and high-pressure ceramic plungers

(D) The digital optical operator touch control display screen

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2022

213. Why is thermography (infrared scanning) used as a predictive maintenance tool in a dairy plant's electrical panels?

(A) To detect thermal hot spots from loose connections or overloads before fires occur

(B) To continuously calculate and measure the relative moisture content of the ambient room air

(C) To visually verify and check if the metal electrical panels are painted the correct color

(D) To measure the electromagnetic field strength of the wiring

2001

214. What is the primary consequence of neglecting the preventive maintenance of mechanical seals on a sanitary centrifugal milk pump?

(A) The high-speed pump motor will begin to generate excessive amounts of electricity

(B) The rotating stainless steel pump impeller will chemically and instantly dissolve

(C) The electrical motor bearings will completely

9. (B) It acts as an insulator, reducing heat transfer efficiency
Milk stone accumulation introduces a major physical barrier within thermal processing systems. Because organic and mineral deposits possess extremely low thermal conductivity compared to stainless steel plates, they act as highly effective thermal insulators. This fouling layer dramatically restricts heat transfer, requiring higher energy inputs and causing processing temperature deviations during pasteurization runs.

10. (B) Van der Waals forces
The initial phase of soil deposition on sanitary surfaces involves physical surface interactions. Before chemical or permanent biological bonds form, weak electromagnetic attractions known as Van der Waals forces draw suspended particles toward the stainless steel boundary. This initial attachment is reversible, allowing pre-rinsing steps to easily dislodge these loosely bound soils before they become chemically baked.

11. (A) Total water hardness (calcium and magnesium)
Water quality is a critical factor in dairy cleaning efficiency. High concentrations of dissolved calcium and magnesium ions represent total water hardness. When exposed to alkaline detergents during cleaning-in-place cycles, these divalent cations react with carbonate and phosphate species, forming insoluble mineral scales that precipitate on equipment surfaces and reduce cleaning performance.

12. (A) Both A and R are true and R is the correct explanation of A.
Soap-based detergents are highly sensitive to the mineral composition of process water. Divalent calcium and magnesium ions present in hard water chemically react with the soluble sodium or potassium salts of fatty acids in soaps. This reaction precipitates insoluble calcium and magnesium soaps, known as scum, which drastically reduces active detergency and deposits residues.

13. (D) Water softening
Water softening is a highly effective pre-treatment technology utilized in dairy plants. It employs a pressurized vessel containing cation-exchange resins loaded with sodium ions. As hard water passes through the resin bed, scale-forming divalent calcium and magnesium cations are selectively captured by the resin, while equivalent sodium ions are released, preventing scale formation in cleaning systems.

14. (C) To bind hard water ions into soluble complexes, preventing scale
Sequestering agents are essential additives in dairy detergents to mitigate the negative effects of hard water. These chemical compounds form stable, water-soluble coordination complexes with dissolved calcium and magnesium ions. By locking these scale-forming cations in solution, sequestering agents prevent them from precipitating as insoluble carbonates or reacting with detergent components during CIP cycles.

15. (B) Staining of steel surfaces and metallic off-flavors in milk
High concentrations of iron in the water supply pose severe operational challenges in dairy plants. Soluble iron oxidizes upon exposure to air or alkaline cleaning agents, depositing reddish-brown rust stains on stainless steel surfaces. Furthermore, residual iron in processing equipment acts as a catalyst for lipid oxidation, causing undesirable metallic off-flavors in dairy products.

16. (D) Hardness from calcium and magnesium bicarbonates that precipitates on boiling
Temporary water hardness is characterized by the presence of dissolved calcium and magnesium bicarbonate salts. When water is heated or boiled during thermal processing, these soluble bicarbonates undergo thermal decomposition. This chemical reaction releases carbon dioxide gas and yields insoluble calcium carbonate and magnesium hydroxide precipitates, which form tough mineral scales on heat exchanger plates.

17. (D) Hardness levels exceeding 150 to 200 ppm
Water classification dictates the necessity of conditioning equipment in food plants. Total hardness levels exceeding one hundred fifty to two hundred parts per million are classified as very hard. Operating cleaning-in-place systems with untreated water in this range results in rapid scale deposition, detergent neutralization, and restricted flow, necessitating the installation of automated water softeners.

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(C) The holding tube structural stainless steel support brackets
(D) The high-pressure homogenizer hydraulic process pressure gauge

2001
222. Why must elastomeric hygienic seals (like tri-clamp gaskets) be replaced systematically even if they do not yet leak liquid?
(A) They become too financially expensive and complex to continuously track on the inventory books
(B) They undergo specialized chemical reactions and naturally turn into hard metallic structures over time
(C) They suffer cold flow, become brittle, and develop micro-cracks that harbor bacteria
(D) They gradually decompose and release highly toxic chemical gases when they age in dry environments

2006
223. What specific maintenance practice is required when greasing bearings on a sanitary pump located directly above an open cheese vat?
(A) Use as much standard high-temperature heavy grease as possible to ensure the bearing never squeaks
(B) Use heavy-duty black industrial molybdenum grease to provide better mechanical wear protection
(C) Completely avoid greasing the biological bearings to eliminate any chemical contamination risk
(D) Use NSF H1 food-grade grease carefully to avoid over-greasing and dripping into product

2005
224. During sanitary maintenance, when a piece of stainless steel equipment is modified or re-welded, what critical post-weld treatment must be applied?
(A) It must be thoroughly painted with heavy-duty rust-proof red oxide primer to prevent surface corrosion
(B) It must be completely coated with a thick protective layer of food-safe chemical epoxy resin sealant
(C) It must be ground smooth, polished, and chemically passivated to restore the chromium oxide layer
(D) It must be heavily chlorinated using highly concentrated sodium hypochlorite solutions for sanitation

2024
225. What is the correct sanitary protocol regarding tools used by maintenance employees on the dairy processing floor?
(A) Standard maintenance tools should be placed directly on the internal product-contact surfaces for maximum convenience
(B) Engineers must use dedicated, sanitized tools and account for them to prevent foreign body contamination
(C) Hand tools used on the dirty effluent treatment plant can be used immediately on the pasteurizer after a simple dry cloth wipe
(D) Specialized tools must be permanently left inside the running machine enclosure to facilitate rapid adjustments

2007
226. If a sanitary pump is dismantled for maintenance, what is the best practice regarding the O-rings upon reassembly?
(A) Re-use the existing physical seals and O-rings indefinitely to save operational maintenance money
(B) Manually stretch them out using mechanical heat tools if they have shrunk during clean-in-place operations
(C) Securely glue the dry rubber seals directly into place using high-strength industrial cyanoacrylate superglue
(D) Replace them with new O-rings lightly lubricated with food-grade grease to ensure a proper seal

NODIA

2013
227. Instrument calibration is a cornerstone of sanitary maintenance. What is the risk of an uncalibrated temperature probe reading 2 degrees Celsius higher than the actual temperature in a pasteurizer?
(A) The system under-pasteurizes the milk because it reads too high, risking pathogen survival
(B) The liquid milk will be severely overcooked, causing immediate extreme fouling inside the plates
(C) The holding tube steel piping network will physically expand and break due to thermal stresses
(D) The clean-in-place (CIP) system will consume significantly too much concentrated chemical detergent

(C) To steadily increase the physical speed at which manual equipment cleaning is performed
(D) To significantly reduce the total monthly wages and benefits paid to processing staff

2005

200. Why is the wearing of personal jewelry (rings, watches, necklaces) strictly prohibited on the dairy processing floor?
(A) They can cause bright reflective light glares that blind automated optical sorting sensors
(B) They cause electromagnetic fields that directly interfere with high-accuracy flow meters
(C) They pose physical hazards if lost, and they harbor bacteria, hindering handwashing
(D) They are highly unstable and can dissolve easily when exposed to caustic CIP chemicals

2024

201. Given below are two statements: one is labelled as Assertion (A) and the other is labelled as Reason (R).
Assertion (A): Dairy plant personnel working in the raw milk receiving area should not freely walk into the post-pasteurization packaging area.
Reason (R): Movement from raw to pasteurized zones creates a high risk of cross-contamination, potentially introducing pathogens like Listeria into the finished product.
Which of the following is correct?
(A) Both A and R are true and R is the correct explanation of A
(B) Both A and R are true but R is not the correct explanation of A
(C) A is true but R is false
(D) A is false but R is true

2025

202. What is a standard GMP requirement for personnel footwear in high-care dairy processing zones?
(A) Using dedicated sanitary boots sanitized via a boot-wash or footbath before entry
(B) Wearing highly comfortable, open-toed sandals to allow maximum ventilation
(C) Wearing standard outdoor industrial street shoes covered in soil and mud deposits
(D) Working entirely barefoot to eliminate any risk of footwear-related contamination

2025

203. Which of the following conditions mandates the immediate exclusion of an employee from handling open dairy products or clean equipment?
(A) The employee is wearing a freshly laundered, clean processing uniform
(B) The employee has gastrointestinal symptoms or open, infected skin wounds
(C) The employee has just successfully completed the standard handwashing protocol
(D) The employee is actively carrying a freshly calibrated dial thermometer

2007

204. Why are colorful, metal-detectable band-aids strictly required if an employee has a minor cut on their hand?
(A) To visually make the injured employee feel better and provide immediate psychological comfort on the floor
(B) To allow blue metal-detectable dressings to be easily seen and caught by inline metal detectors
(C) Because copper and steel metals help heal deep open flesh wounds faster through localized magnetic field therapy
(D) Because the inner metallic strip acts as a slow-release chemical sanitizer directly on the skin surface

2021

205. In a food safety culture, how often should basic GMP and GHP training be provided to dairy plant personnel?
(A) At induction, and refreshed regularly or whenever procedures change
(B) Only once during the very first day of their initial employment
(C) Exclusively in response to a major active foodborne illness outbreak
(D) Only to members of the executive and upper-level management team

2016

206. What is the correct protocol for an employee navigating through a footbath at the entrance of a processing room?
(A) Jump completely over the wet footbath to avoid getting clean processing boots wet
(B) Carefully walk on the dry, elevated metal edges surrounding the active liquid
(C) Step directly into the sanitizer, ensuring boot treads are submerged to kill pathogens
(D) Completely drain the dirty chemical footbath liquid before entering the room

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ANSWERS

1. (A) Calcium phosphates enmeshed with denatured proteins and lipids
Traditional milk stone consists of calcium phosphates and other minerals bound in a matrix of proteins and fats. Heated surfaces promote the precipitation of calcium salts, which embed denatured proteins and lipid fractions. This complex soil forms a hard, stubborn deposit that requires systematic alkaline and acid cleaning steps for complete removal from dairy contact surfaces.

2. (C) Beta-lactoglobulin
Thermal treatment of milk above critical pasteurization temperatures causes the denaturation of whey proteins. Among these, beta-lactoglobulin is highly heat-sensitive and exposes reactive sulfhydryl groups upon unfolding. These active groups facilitate initial absorption and subsequent polymerisation at hot stainless steel interfaces, establishing the foundational fouling layer that attracts other milk solids.

3. (A) Soft, protein-rich deposits formed between 75 and 85 degrees Celsius
Milk fouling deposits are classified based on temperature and composition. Type A deposits accumulate in the moderate temperature range and are highly organic, consisting of over fifty percent proteins along with minerals. This soil is physically soft, voluminous, and spongy, making it highly responsive to alkaline cleaning agents designed to peptize and dissolve organic protein matrices.

4. (D) It bridges proteins to the stainless steel surface, worsening fouling
Ionic calcium plays a pivotal role in the biochemical mechanism of thermal dairy fouling. Free divalent calcium ions promote protein aggregation by reducing electrostatic repulsion between unfolded whey molecules. Furthermore, these cations function as structural bridges that link negatively charged protein groups directly to the stainless steel oxide layer, accelerating soil deposition and adhesion.

5. (B) Peptization
Cleaning organic soils requires specific physical and chemical processes. Peptization is the chemical breakdown and dispersion of large, insoluble denatured protein networks into smaller, highly colloidal particles. Alkaline cleaning solutions achieve this by hydrolyzing peptide bonds and generating negative charges on proteins, which promotes dispersion and prevents the redeposition of proteinaceous soil on equipment surfaces.

6. (C) Hydroxyl ions saponify triglycerides into soluble soaps
Milk lipids consist primarily of triglycerides, which are insoluble in water and tend to form greasy films. Alkaline cleaning solutions provide a high concentration of hydroxyl ions, which chemically hydrolyze the ester bonds of these triglycerides. This saponification reaction converts insoluble fats into glycerol and soluble sodium soaps, which are easily rinsed away during cleaning.

7. (D) Type A is protein-rich (lower temperatures); Type B is mineral-rich (higher temperatures)
Dairy fouling is characterized by temperature-dependent chemical compositions. Type A deposits form at pasteurization temperatures and are predominantly composed of whey proteins, resulting in a soft structure. Conversely, Type B deposits develop at sterilizing temperatures above one hundred degrees Celsius, where mineral precipitation dominates, producing a highly dense, mineral-rich scale that is difficult to dissolve.

8. (A) Unfolding of the native protein, transport to the surface, aggregation and adherence, cross-linking
Thermal fouling of whey proteins proceeds through a precise thermodynamic sequence. Heat first induces conformational changes, causing the unfolding of native globular protein structures. These reactive molecules are transported to the boundary layer, where they aggregate and adhere to the metal surface. Finally, chemical cross-linking via disulfide bonds stabilizes the foulant layer on the equipment.

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lock up and freeze solid immediately
(D) The pump will leak product externally or draw ambient air into the product stream

2021

215. Match the predictive/preventive maintenance technique in List I with its target application in List II.

List I: (Maintenance Technique)
P. Vibration Analysis
Q. Oil Condition Analysis
R. Ultrasonic Leak Detection
S. Thermography

List II: (Target Application)
1. Identifying micro-fissures in compressed air lines
2. Detecting premature wear in high-speed separator bearings
3. Finding overloaded contacts in motor control centers
4. Monitoring the degradation of gearbox lubricants

(A) P-3, Q-1, R-4, S-2
(B) P-2, Q-4, R-1, S-3
(C) P-4, Q-2, R-1, S-3
(D) P-2, Q-1, R-4, S-3

2002

216. How does a Computerized Maintenance Management System (CMMS) assist a dairy plant?
(A) It automatically runs sanitizing solutions and cleans processing equipment overnight
(B) It biologically and chemically formulates advanced new dairy product recipes
(C) It tracks assets, schedules work orders, manages spare parts, and logs breakdowns
(D) It performs automated laboratory assays and tests milk for bacterial contamination

2001

217. In the context of plate heat exchangers (pasteurizers), what preventive maintenance action must be periodically performed to prevent cross-contamination between raw and pasteurized sides?
(A) Periodically painting the exterior surfaces of the plates with anti-corrosion paint
(B) Securely welding all individual stainless steel plates together permanently in blocks
(C) Thickly coating the internal heat transfer plates with heavy food-grade grease
(D) Pressure testing and replacing plate gaskets before they become brittle and fail

2005

218. When scheduling maintenance for a dairy centrifuge (clarifier or separator), why is precise dynamic balancing critical?
(A) To prevent violent vibrations at high RPM that cause catastrophic structural failure
(B) Because highly unbalanced rotor bowls inherently consume significantly less electrical energy
(C) To actively ensure that the fluid milk does not prematurely curdle and coagulate inside
(D) To mechanically allow the internal gearing systems to operate completely without lubrication

2021

219. What is a "run-to-failure" strategy, and where might it be appropriately used in a dairy plant?
(A) Consistently running critical processing homogenizers until they break down; never appropriate
(B) Postponing maintenance until failure; acceptable only for low-cost, non-critical items
(C) Operating high-pressure steam boilers until they explode to test critical safety valves
(D) Applying a run-to-failure strategy for all sanitary pumps to save money on spare parts

2017

220. What is the fundamental difference between standard industrial lubricants and "food-grade" lubricants used in a dairy plant?
(A) Food-grade lubricants are highly specialized organic liquids made exclusively from raw butter and milk fat
(B) Food-grade lubricants (NSF H1) are non-toxic, posing no hazard if incidental product contact occurs
(C) Standard heavy industrial lubricants are chemically modified and much safer for direct human consumption
(D) Food-grade synthetic lubricants are designed with permanent molecular structures and never require replacement

2022

221. Which critical control point (CCP) instrument in a HTST pasteurizer requires systematic, legally mandated sanitary maintenance and calibration?
(A) The indicating thermometer and Safety Thermal Limit Recorder
(B) The exterior volumetric electromagnetic discharge flow meter

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18. (B) II, I, IV, III
Ion-exchange water softening operates through a structured cycle of phases. The active service run allows hard water to pass through the resin bed for softening. Next, backwashing fluidizes the resin and removes physical particulates. Regeneration then introduces highly concentrated sodium chloride to restore resin capacity. Finally, a fast rinse removes excess brine before returning to service.

19. (A) Chlorides induce pitting and stress corrosion cracking in stainless steel
Elevated chloride levels in processing water present a severe threat to structural integrity. Chloride ions actively penetrate the passive chromium oxide protective layer of stainless steel surfaces. This localized chemical penetration triggers pitting and stress corrosion cracking, especially at elevated processing temperatures, leading to permanent equipment damage and potential micro-leakage in heat exchangers.

20. (D) EDTA complexometric titration with Eriochrome Black T indicator
Determining total water hardness requires precise analytical quantification of calcium and magnesium ions. The standard laboratory method utilizes complexometric titration with ethylenediaminetetraacetic acid under buffered alkaline conditions. Eriochrome Black T serves as the indicator, changing from wine-red to a distinct blue endpoint when all hardness cations have been successfully chelated by the titrant.

21. (B) Wetting
Successful cleaning-in-place operations require effective surface interaction. Wetting is the physicochemical mechanism where surface-active agents in a detergent lower the interfacial tension of the cleaning solution. This action allows the wash liquid to spread rapidly across hydrophobic soiled surfaces, penetrating microscopic crevices and ensuring intimate chemical contact between the cleaning solution and the soil.

22. (C) Suspending liquid fat droplets in the solution to prevent redeposition
Emulsification is a fundamental physical mechanism in the removal of lipid soils. Detergent surfactants position themselves at the interface between water and immiscible dairy fats. By reducing interfacial tension, they break up large fat masses into micro-droplets, surrounding them to prevent coalescence and redeposition onto cleaned stainless steel surfaces during cleaning cycles.

23. (D) The chemical breakdown and dispersion of proteins into colloidal solutions
Dairy soil contains complex, insoluble protein networks that adhere firmly to equipment walls. Peptization is the chemical process whereby alkaline cleaning agents break down these large, cohesive protein matrices into smaller, highly hydrated colloidal fragments. This molecular fragmentation allows the soil to be dispersed into the flowing cleaning solution and easily carried out of the system.

24. (A) Dispersion
Effective detergency must ensure that removed soils are successfully carried out of the equipment. Dispersion is the specific detergent property that maintains fine, insoluble solid soil particles in a suspended state throughout the wash fluid. By preventing these particles from aggregating or settling, dispersion ensures they are completely flushed out of the system during rinsing.

25. (A) P-4, Q-3, R-1, S-2
Detergency relies on distinct chemical and physical mechanisms to remove milk soils. Saponification chemically hydrolyzes fats into soluble soaps using alkaline agents. Sequestration binds hard water ions to prevent mineral precipitation. Wetting reduces the surface tension of water to allow spreading. Emulsification suspends immiscible fat droplets within the washing fluid to prevent redeposition.

26. (B) Critical Micelle Concentration (CMC)
Surfactants exhibit unique behaviors based on concentration. When added to water, surfactant monomers first align at the air-water interface. Upon reaching a specific threshold known as the critical micelle concentration, the solution becomes saturated with monomers, which spontaneously self-assemble into spherical aggregates called micelles, enabling the encapsulation and removal of hydrophobic soils.

27. (A) By forming coordination bonds with metal ions to prevent scale
Chelating agents are key functional ingredients in dairy detergents. They possess multiple electron-donating atoms that form stable, ring-structured coordination complexes with multivalent metal

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ideal for energy-saving CIP systems. Ozone is highly unstable and requires specialized, on-site generation. Peracetic acid sanitizes by releasing reactive oxygen species. These established principles make statements regarding PAA and ozone highly accurate for modern dairy plants.

66. (B) 254 nm
The germicidal effectiveness of electromagnetic radiation peaks in the shortwave ultraviolet spectrum. At a wavelength of approximately two hundred fifty-four nanometers, ultraviolet light is absorbed most strongly by microbial DNA and RNA. This absorption causes thymine dimerization, permanently disrupting DNA replication and transcription, which inactivates vegetative bacteria, viruses, and fungal spores.

67. (A) Peracetic acid at high concentrations
Bacterial spores possess highly resistant outer coats that shield them from mild sanitizers. At elevated concentrations, peracetic acid functions as a powerful sporicidal agent at ambient temperatures. It achieves this by rapidly penetrating the spore coat and oxidizing key internal proteins and DNA, outperforming standard hypochlorite and quaternary ammonium compounds against resilient Bacillus species.

68. (D) It is unstable and decomposes back into diatomic oxygen rapidly
Ozone is a highly unstable triatomic molecule with a very short half-life in both air and water. It spontaneously and rapidly decomposes back into stable diatomic oxygen, preventing it from being stored, compressed, or transported in bulk cylinders. Consequently, dairy plants utilizing ozone must generate it on-site immediately prior to application.

69. (B) PAA solutions emit pungent vapors, requiring adequate handling area ventilation
While peracetic acid is highly effective and environmentally friendly, it presents specific handling challenges. Concentrated and diluted peracetic acid solutions emit sharp, vinegar-like, and highly irritating vapors. These fumes can cause respiratory discomfort and eye irritation for plant operators, making the installation of adequate localized ventilation systems in chemical handling areas critical.

70. (C) It oxidizes cell membrane amino acids, inhibiting protein synthesis
Chlorine dioxide destroys bacterial cells through a highly targeted biochemical mechanism. It acts as a single-electron transfer oxidant, selectively targeting and oxidizing electron-rich amino acids, such as tyrosine and tryptophan, within the cell membrane. This targeted oxidation disrupts membrane permeability and permanently inhibits vital protein synthesis, leading to rapid cell death.

71. (D) To flush out alkaline detergent residues before acid circulation, preventing neutralization
Multi-step cleaning-in-place sequences require careful separation of incompatible chemicals. The intermediate rinse step utilizes clean water to flush out residual alkaline detergent from the system after the caustic wash. Removing these basic residues prevents them from neutralizing the subsequent acid wash, thereby maximizing the mineral-dissolving efficiency of the acid and reducing chemical waste.

72. (A) The routing mix-proof valve matrix
Modern automated dairy plants require precise fluid routing to ensure food safety. The routing mix-proof valve matrix consists of specialized double-seat valves that physically isolate cleaning solutions from active product lines. Under PLC control, these valves automatically and reliably direct CIP chemicals through target loops while preventing any cross-contamination with pasteurized milk.

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73. (B) Recovery systems reuse detergents, while single-use systems discharge them after one cycle
CIP systems are designed around two primary chemical management philosophies. Single-use systems use fresh cleaning solutions for each cycle and discharge them to the drain immediately after use. Conversely, multi-use, or recovery, systems collect, filter, and store detergents in dedicated tanks, allowing them to be reused in subsequent cleaning cycles to conserve water and chemicals.

74. (B) Hot water denatures residual milk proteins, causing them to bake onto surfaces
Temperature control during the pre-rinse phase is critical for effective cleaning. Using water above sixty-five degrees Celsius denatures soluble whey proteins, causing them to aggregate and bake onto stainless steel surfaces. Utilizing lukewarm

helping to break down the mineral framework of milk stone deposits.

37. (B) 0.5 to 1.5 percent
Determining the correct concentration of caustic soda is vital for cleaning efficiency and safety. Standard automated cleaning-in-place operations for dairy pipelines and storage vessels typically utilize a sodium hydroxide concentration of 0.5 to 1.5 percent. This range provides sufficient active alkalinity to hydrolyze proteins and saponify fats without causing excessive equipment wear.

38. (C) Low-foaming nonionic surfactants
Caustic wash solutions require additives to improve wetting and penetration. Low-foaming nonionic surfactants are selected for automated cleaning-in-place applications. These surfactants reduce surface tension, allowing the caustic solution to penetrate tough milk soils without generating excessive foam, which would otherwise cause pump cavitation and disrupt the turbulent flow necessary for mechanical cleaning.

39. (D) They are converted into water-soluble sodium soaps
Alkaline detergents chemically alter fats to facilitate their removal. Free fatty acids present in milk soils undergo an acid-base neutralization reaction with sodium hydroxide. This reaction converts insoluble, greasy fatty acids into water-soluble sodium soaps. These newly formed soaps help emulsify other fats, making the cleaning process highly efficient and self-reinforcing.

40. (A) Extreme corrosiveness causing severe chemical burns
Concentrated sodium hydroxide is highly hazardous due to its chemical properties. It is extremely corrosive and reacts rapidly with human tissue, causing deep, painful chemical burns and permanent ocular damage upon contact. Consequently, operating personnel must strictly follow safety protocols and wear full personal protective equipment when handling caustic formulations.

41. (B) Removal of mineral deposits and alkaline residues
The acid wash cycle is an essential step in dairy cleaning-in-place programs. It is designed to dissolve mineral scales, such as calcium phosphate and calcium carbonate, which accumulate on processing surfaces. Additionally, the acid wash neutralizes any residual alkaline detergent from the preceding step, preventing the buildup of white mineral films on stainless steel.

42. (B) Nitric acid
Nitric acid is the most widely utilized inorganic acid in dairy cleaning-in-place operations. It is highly effective at dissolving stubborn calcium-based mineral scales. Furthermore, nitric acid is a strong oxidizing agent that promotes the formation of a passive chromium oxide protective layer on stainless steel, enhancing the metal's natural resistance to future corrosion.

43. (A) It promotes severe pitting and stress corrosion in stainless steel
Hydrochloric acid is avoided in routine dairy cleaning due to its highly destructive nature. The chloride ions in this mineral acid attack the protective passive chromium layer of stainless steel. This chemical attack results in severe localized pitting, crevice corrosion, and stress corrosion cracking, which permanently damages expensive processing equipment and creates bacterial harborages.

44. (C) It provides detergency and is less corrosive to stainless steel than other mineral acids
Phosphoric acid is frequently blended with nitric acid in commercial acid cleaners. It is less corrosive to stainless steel than other mineral acids and provides excellent soil-wetting properties. This acid helps dissolve mineral scale and prevents the redeposition of mineral-protein complexes, making it highly effective for maintaining clean surfaces on plate heat exchangers.

45. (A) Both A and R are true and R is the correct explanation of A.
Organic acids, including citric and gluconic acids, are ideal for manual cleaning applications in dairy plants. Because they are weak acids, they do not present the severe chemical burn hazards associated with concentrated mineral acids. This makes them significantly safer for personnel to handle and prevents damage to sensitive seals, copper, or brass fittings.

46. (C) Hydrogen ions convert insoluble calcium phosphates into soluble salts
Milk stone consists of insoluble calcium phosphate complexes embedded in a protein matrix. Acid detergents supply a high concentration of hydrogen ions, which chemically

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react with insoluble calcium phosphate. This reaction converts the phosphate into highly soluble calcium hydrogen phosphate and free calcium ions, dissolving the mineral structure and releasing the entrapped organic soil.

47. (B) Concentration of 0.5-1.0% at 60-70 degrees Celsius
Optimizing the parameters of a nitric acid wash is critical for effective cleaning and safety. A typical dairy cleaning-in-place circuit operates with a nitric acid concentration of 0.5 to 1.0 percent. The solution is circulated at temperatures between 60 and 70 degrees Celsius to accelerate the dissolution of mineral scale without causing thermal degradation of gaskets.

48. (D) Eutrophication of receiving waters due to high phosphorus discharge
Phosphoric acid detergents present significant environmental challenges when discharged into wastewater streams. High phosphorus levels in plant effluent bypass standard treatment and enter natural water bodies. This nutrient enrichment triggers rapid algal blooms, leading to eutrophication, oxygen depletion, and the degradation of aquatic ecosystems, prompting many regions to restrict phosphate-based cleaning products.

49. (A) Acids precipitate remaining proteins onto the surface, making them very hard to remove
Sequencing is critical in cleaning-in-place operations. If acid is introduced before a thorough pre-rinse and alkaline wash have removed the bulk of the proteins, the low pH will instantly denature and precipitate the remaining proteins. This creates a highly resistant, baked-on organic-mineral film that is extremely difficult to remove during subsequent cleaning cycles.

50. (C) II and IV
Understanding the correct properties of acid detergents is critical for dairy cleaning. Phosphoric acid is highly compatible with stainless steel and is widely used, not restricted to plastic. Furthermore, acid detergents dissolve minerals, whereas alkaline solutions are required to saponify lipid deposits. Therefore, statements describing phosphoric acid as highly corrosive and acids as lipid saponifiers are incorrect.

51. (A) Oxidation of structural proteins and vital cellular enzymes
Chlorine-based sanitizers are powerful, fast-acting antimicrobial agents. They function by releasing hypochlorous acid, which easily penetrates bacterial cell membranes. Once inside, this highly reactive chemical oxidizes sulfhydryl groups on structural proteins and key metabolic enzymes, disrupting cellular function, halting energy production, and leading to rapid cell death.

52. (D) Slightly acidic to neutral (pH 5.5-7.0)
The antimicrobial efficacy of chlorine sanitizers is highly dependent on pH. In solution, sodium hypochlorite exists in equilibrium between hypochlorous acid and hypochlorite ions. Maintaining a slightly acidic to neutral pH range of 5.5 to 7.0 maximizes the concentration of hypochlorous acid, which is significantly more effective at penetrating bacterial cell membranes than the charged hypochlorite ion.

53. (B) They release elemental iodine slowly from a surfactant complex
Iodophors are formulated sanitizers that consist of elemental iodine complexed with a nonionic surfactant carrier. This chemical structure stabilizes the iodine and slowly releases active, free diatomic iodine when diluted with water. This controlled release provides sustained antimicrobial activity, reduces stain potential, and minimizes skin irritation for operators handling the solution.

54. (C) Cationic surfactants that disrupt cell membranes, causing leakage and death
Quaternary ammonium compounds are cationic surfactants widely used for environmental sanitization. Their positive charge allows them to adsorb onto the negatively charged cell walls of vegetative bacteria. This physical adsorption leads to the penetration of their hydrophobic tails into the lipid bilayer, causing severe membrane disruption, leakage of essential intracellular contents, and cell death.

55. (D) Sodium hypochlorite
Sodium hypochlorite must be managed carefully in dairy plants. At high concentrations or during extended contact times, the active chlorine species and free chloride ions attack the passive chromium oxide protective layer of stainless steel. This chemical attack initiates rapid pitting

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and localized corrosion, particularly under warm, acidic conditions, shortening equipment lifespan.

56. (A) QACs leave a residual antimicrobial film, whereas chlorine dissipates quickly
Environmental surfaces like floors and walls require long-lasting microbial control. Quaternary ammonium compounds are chemically stable and do not evaporate easily, leaving a residual, bacteriostatic film on treated surfaces that prevents microbial growth over time. In contrast, chlorine-based sanitizers decompose and dissipate rapidly, providing no residual antimicrobial protection after drying.

57. (B) The solution maintains a distinct amber/yellow color
Monitoring sanitizer strength is critical for ensuring food safety. Iodophor sanitizers exhibit a natural, concentration-dependent visual property due to the presence of active iodine complexes. As long as the solution maintains a distinct amber or light-yellow color, it contains sufficient active iodine. If the color fades or disappears, the active iodine has been depleted.

58. (B) The presence of high organic loads
The efficacy of chlorine-based sanitizers is severely compromised by organic soils. Hypochlorous acid is a non-selective oxidizer that reacts rapidly with milk proteins and fats instead of target microorganisms. This reaction consumes the available free chlorine, leaving insufficient active sanitizer in the solution to achieve effective microbial reduction on the equipment surfaces.

59. (A) They inhibit starter cultures at trace levels, causing manufacturing failure
Quaternary ammonium compounds adhere strongly to stainless steel surfaces. If they are not thoroughly rinsed from cheese vats, trace residues can bleed into incoming milk. These residual cationic surfactants are highly inhibitory to lactic acid starter cultures, halting fermentation, disrupting acid development, and leading to complete failure of the cheese manufacturing process.

60. (C) They sublimate and lose iodine gas rapidly at temperatures above 45-50 degrees Celsius
Operating temperatures must be closely controlled when using iodophor sanitizers. At temperatures exceeding forty-five to fifty degrees Celsius, elemental iodine becomes unstable and undergoes rapid sublimation, turning directly into a purple gas. This rapid loss of active iodine depletes the sanitizing power of the solution and creates corrosive, irritating vapors in the plant.

61. (D) It decomposes solely into acetic acid, oxygen, and water
Peracetic acid is an advanced, highly environmentally friendly sanitizer. Its chemical structure consists of an equilibrium mixture of acetic acid and hydrogen peroxide. Upon application and contact with organic soils or water, peracetic acid rapidly decomposes into harmless byproducts, specifically acetic acid, oxygen, and water, leaving no toxic residues or halogenated compounds in wastewater.

62. (C) Ozonation
Ozonation is an advanced, residue-free sanitizing technology. Ozone gas is generated on-site by exposing oxygen to an electrical discharge. When dissolved in water, ozone acts as an extremely powerful, unstable oxidizer that rapidly destroys bacterial cells and biofilms. It quickly degrades back into diatomic oxygen, eliminating the need for a final rinse.

63. (B) It only acts on line-of-sight surfaces, failing to penetrate opaque fluids
Ultraviolet irradiation is a non-chemical sanitizing method with distinct physical limitations. UV light must directly strike a microorganism to disrupt its DNA. Consequently, it only sanitizes line-of-sight surfaces and cannot penetrate shadows, crevices, or opaque dairy fluids like milk, limiting its use to water disinfection and air treatment.

64. (D) Chlorine dioxide is less affected by organic matter and does not form chloramines
Chlorine dioxide is a highly selective oxidant with superior sanitizing properties. Unlike standard sodium hypochlorite, it does not react with ammonia or organic nitrogen compounds, preventing the formation of toxic chloramines. This selectivity allows chlorine dioxide to maintain high sanitizing efficacy in the presence of organic loads, making it highly effective in dairy water systems.

65. (B) I, II and V
Advanced sanitization technologies offer distinct operational characteristics. Peracetic acid remains highly effective in cold temperatures, making it

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polished to a high finish make it highly cost-effective.

104. (A) AISI 316
Processing highly corrosive fluids requires superior materials. AISI 316 stainless steel is specified for applications involving high chloride concentrations, acid sanitizers, or high temperatures. The addition of molybdenum to this alloy significantly enhances its resistance to pitting and crevice corrosion, ensuring long-term structural integrity in demanding environments.

105. (A) I, II and IV
Sanitary design principles prevent bacterial harborage. Equipment must be self-draining to prevent pooling, and hollow bodies must be hermetically sealed to block moisture and bacterial ingress. Furthermore, dead legs in piping should be eliminated or minimized. However, sharp 90-degree corners are not preferred as they create pockets that resist cleaning.

106. (B) The thread roots harbor soil and bacteria unreachable by CIP
Threaded connections are prohibited in the product-contact areas of sanitary pipelines. The sharp roots of the threads create microscopic, tight crevices where milk solids and bacteria accumulate. Because cleaning fluids cannot achieve turbulent flow or contact within these spaces during CIP cycles, threaded fittings present severe contamination risks.

107. (A) Sanitary Tri-Clamp fittings with flush elastomeric gaskets
Connecting sanitary pipelines requires fittings that prevent crevices. Sanitary Tri-Clamp fittings are universally used in the dairy industry. This design compresses a flush elastomeric gasket between two mating ferrules, creating a smooth, continuous, and crevice-free internal joint that prevents soil accumulation and is easily cleaned during automated CIP cycles.

108. (C) They must be continuously welded, ground smooth, and radiused
The internal corners of processing vessels present cleaning challenges. To prevent soil build-up, these corners must be continuously welded, ground smooth, and radiused to a minimum curve. This design eliminates sharp seams and crevices, allowing cleaning-in-place solutions to flow smoothly over the entire surface to achieve complete sanitation.

109. (D) Ethylene Propylene Diene Monomer (EPDM)
Elastomers used for gaskets in dairy systems must withstand harsh conditions. Ethylene Propylene Diene Monomer is a highly durable polymer that exhibits excellent chemical resistance to both acid and alkaline cleaning agents. Furthermore, EPDM is highly stable when exposed to milk fats and high processing temperatures, making it a standard choice.

110. (C) By using an air gap and double-seat layout with an atmospheric vent
Double-seat mix-proof valves prevent the cross-contamination of products and cleaning chemicals. They incorporate two independent valve seats separated by a leakage chamber that is vented directly to the atmosphere. If a seal fails, the fluid drains safely out of the vent, preventing chemicals from entering the active product line.

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111. (B) They work at neutral pH and lower temperatures, saving energy and hazards
Enzyme-based bio-detergents offer significant advantages over traditional harsh chemicals. These formulations operate efficiently at neutral pH and lower temperatures, typically between forty and fifty degrees Celsius. This mild operation reduces energy consumption, minimizes the risk of chemical burns for operators, and protects sensitive equipment from corrosive damage.

112. (D) Proteases
Whey proteins form highly resilient, denatured films on processing surfaces. To degrade these organic matrices, bio-detergents are formulated with proteases. These specialized enzymes catalytically hydrolyze the peptide bonds within the protein chains, breaking them down into small, highly soluble peptides and amino acids that are easily washed away by the cleaning solution.

113. (A) Lipase
Milk fats can accumulate as persistent, greasy films in cold raw milk transport pipelines. To target these lipid deposits without using high temperatures or strong alkalis, bio-detergents incorporate lipases. These enzymes catalytically hydrolyze the ester bonds of triglycerides,

water between thirty-five and forty-five degrees Celsius melts milk fat and flushes out organic residues without precipitating proteins onto the equipment.

75. (A) Conductivity transmitter
Automated detergent dosing and phase separation rely on real-time chemical measurements. A conductivity transmitter installed in the CIP return line measures the electrical conductivity of the flowing liquid. Since alkaline and acid detergents increase ionic conductivity, this sensor allows the control system to accurately monitor chemical strength and detect phase changes between detergent and rinse water.

76. (C) An acid wash to remove mineral scale
Cleaning heated surfaces like pasteurizers requires a structured chemical sequence. After the caustic wash has broken down the organic protein and lipid layers, and an intermediate rinse has removed the alkaline residues, an acid wash is introduced. This step is designed to dissolve the remaining mineral scale, predominantly calcium phosphate, from the plates.

77. (D) A pipe section where fluid velocity drops to zero, allowing bacterial harborage
Sanitary piping layouts must eliminate physical features that compromise cleaning. A dead leg is any tee or branch section of pipe where the cleaning fluid velocity drops to zero during circulation. This lack of flow prevents turbulent scrubbing and chemical contact, allowing milk residues and bacteria to accumulate and form highly resilient biofilms.

78. (A) P-2, Q-3, R-4, S-1
Automated CIP systems rely on several integrated components to clean equipment. The supply pump drives cleaning fluid through processing lines. The scavenge pump pulls returning fluid back to prevent pooling in tanks. The conductivity probe monitors detergent concentration for automated dosing. Finally, the heat exchanger maintains the cleaning solution at the target temperature.

79. (B) By using spray balls or rotary jet heads at the top of the vessel
Cleaning large vertical storage silos requires specialized fluid distribution. Rather than flooding the entire vessel, spray balls or rotary jet heads are mounted at the top of the silo. These devices distribute the CIP solution in a continuous, cascading falling film that covers all internal walls, providing the mechanical action needed to wash away residues.

80. (D) It contains high levels of soil and organic matter that would deplete detergent strength
Pre-rinse water is routed directly to the drain to protect the recovery system. This initial rinse flushes out over ninety percent of the loose milk soil and organic residues from the lines. If this heavily soiled water were recovered, it would rapidly deplete detergent strength, clog filters, and contaminate clean washing solutions in the recovery tanks.

81. (A) Time, Action, Concentration, Temperature
The cleaning process is governed by four fundamental, interdependent parameters represented by the TACT acronym. These parameters are exposure time, mechanical action, chemical concentration, and thermal temperature. Balancing these four elements is essential for optimizing cleaning-in-place cycles, ensuring consistent soil removal while minimizing chemical waste, energy consumption, and equipment wear.

82. (B) 1.5 meters per second
Achieving adequate mechanical action is critical for cleaning closed pipelines. To ensure sufficient turbulent flow that can physically scrub soil from pipe walls, CIP systems must maintain a minimum fluid velocity of 1.5 meters per second. This velocity overcomes gravity and surface adhesion, keeping dislodged milk solids suspended until they can be flushed out.

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83. (A) Reynolds number
Fluid dynamics in sanitary pipelines are characterized by the Reynolds number. This dimensionless value represents the ratio of inertial forces to viscous forces. To transition from laminar flow to the highly turbulent flow necessary for effective mechanical cleaning-in-place, the Reynolds number in the circuit must exceed a minimum threshold of four thousand.

84. (D) Temperature or wash time must be appropriately increased
The four parameters of the TACT circle operate in a highly interdependent manner. If one parameter, such as chemical concentration, is reduced to meet environmental goals, the overall

cleaning efficacy will decrease. To compensate for this reduction and maintain cleaning standards, the system must increase other parameters, such as circulation temperature or wash time.

85. (B) II and III
Optimizing cleaning-in-place parameters requires balancing chemical and physical factors. Excessive fluid velocity can cause pressure drops and pump cavitation, leading to poor cleaning. Furthermore, TACT parameters are deeply interdependent, meaning changes in one require adjustments in the others. However, indefinitely increasing caustic temperature is incorrect as it can bake on proteins.

86. (C) It can bake proteins onto the surface and cause thermal shock to equipment
Raising the temperature of a caustic wash beyond recommended limits introduces significant operational risks. Excessively high temperatures denature residual proteins in the system, causing them to bake onto stainless steel surfaces as a tough, insoluble film. Additionally, extreme temperature transitions can cause thermal shock, damaging gaskets, sensors, and structural components.

87. (D) By the cascading falling film distributed by the spray ball
Unlike pipelines, the interior surfaces of large dairy silos cannot rely on high fluid velocity for turbulent scrubbing. Instead, the mechanical action is generated by a falling film of cleaning solution. The spray ball distributes the fluid over the top of the silo, allowing gravity to pull a cascading film down the vertical walls to remove soil.

88. (A) Action
A sudden drop in the flow rate of a cleaning-in-place circuit has immediate consequences. This flow reduction compromises the mechanical action parameter of TACT, as it drops the fluid velocity below the critical threshold required for turbulence. Without turbulent scrubbing, the system cannot physically dislodge and transport soils from the pipe walls.

89. (B) Inadequate wetting, penetration, and soil suspension
Time is a critical parameter in the chemical cleaning process. If the circulation time of the detergent is insufficient, the chemical reactions cannot proceed to completion. This short contact time results in inadequate wetting and penetration of the soil matrix, failing to break down and suspend the milk residues within the flowing solution.

90. (B) Excess concentrations cause residues, waste treatment burdens, and equipment corrosion
Increasing chemical concentration beyond the optimum range does not improve cleaning efficiency and introduces several disadvantages. Excess detergent is difficult to rinse away, leaving residues on surfaces. Furthermore, it increases chemical costs, accelerates the corrosion of gaskets and stainless steel, and places a heavy chemical oxygen demand burden on the wastewater treatment plant.

91. (A) Parts are disassembled, placed in a specialized tank, and cleaned via agitated flow
Cleaning-out-of-place is a specific sanitation protocol used for complex equipment. It requires operators to manually disassemble components and place them in a specialized parts washer tank. Once loaded, the tank circulates a heated detergent solution, generating highly turbulent, agitated flow that cleans all internal and external surfaces of the disassembled parts.

92. (C) Dismantlable parts, filler valves, and pump impellers
Certain dairy equipment components cannot be effectively cleaned using automated cleaning-in-place systems. These include items with tight tolerances, internal threads, or moving parts, such as filler valves, positive displacement pump impellers, and manual valves. These components must be disassembled and subjected to cleaning-out-of-place protocols to ensure complete soil removal.

93. (D) By using high-velocity jets or impellers that create rolling turbulence
Generating mechanical action in a parts washer tank is essential for soil removal. Rather than manual scrubbing, these tanks utilize integrated high-velocity jets or motorized impellers. This design creates continuous rolling turbulence within the bath, ensuring that the flowing detergent solution contacts all surfaces of the submerged parts to scrub away residues.

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94. (C) Using Personal Protective Equipment such as chemical gloves, goggles, and aprons
Manual cleaning operations expose personnel to concentrated chemical agents and hot water. To mitigate these hazards and prevent injury, operators must wear appropriate personal protective equipment. This safety gear includes chemical-resistant gloves, safety goggles, and protective aprons, shielding personnel from accidental chemical splashes or thermal burns during cleaning procedures.

95. (B) Using abrasive tools like steel wool or metallic scrapers
Manual cleaning of sanitary dairy components requires gentle physical methods. Operators must avoid using abrasive tools such as steel wool or metallic scrapers, as these materials scratch polished stainless steel surfaces and damage synthetic gaskets. These micro-scratches destroy the sanitary surface finish, creating crevices where bacteria and soil can accumulate.

96. (D) Foam increases chemical contact time on vertical surfaces and visually indicates coverage
Foaming properties are highly advantageous in manual cleaning formulations. The generation of rich, stable foam allows the detergent to cling to vertical and overhead surfaces, extending chemical contact time on the soil. Additionally, the visible foam layer provides a clear visual indicator to operators, ensuring complete coverage and preventing areas from being missed.

97. (A) Parallel to the fluid jet flow to allow solution to pass completely through them
Loading configurations in parts washer tanks determine cleaning effectiveness. Long tubular fittings and pipe sections must be positioned parallel to the direction of the fluid jet flow. This orientation allows the turbulent detergent solution to pass completely through the pipes, ensuring that internal surfaces receive sufficient mechanical and chemical action.

98. (A) Both A and R are true and R is the correct explanation of A.
Complex mechanical parts require regular physical teardown for cleaning. Components like positive displacement pumps and manual plug valves contain tight clearances and internal seals that block the path of circulating CIP fluids. Because automated cleaning cannot generate turbulent flow in these crevices, daily manual disassembly and COP cleaning are necessary.

99. (A) Hot, highly concentrated nitric acid
Chemical selection in open-tank parts washers must prioritize personnel safety. Hot, highly concentrated nitric acid is avoided in COP tanks because it releases hazardous, corrosive fumes upon heating. These acid vapors pose severe inhalation risks to operators working nearby, necessitating the use of safer, low-foaming, and non-volatile cleaning formulations in these systems.

100. (D) Clean from top to bottom, preventing re-soiling of cleaned areas
Establishing a structured physical sequence is critical for effective manual cleaning. Operators must always scrub equipment surfaces from the top down to the bottom. This directional approach ensures that dislodged soil, dirty water, and detergent residues cascade downward over uncleaned surfaces, preventing the re-contamination of previously cleaned areas.

101. (B) The arithmetical mean roughness of the surface profile
Surface finish quality is a key parameter in sanitary design. The R_a value is the internationally recognized measurement of the arithmetical mean roughness of a surface profile. It quantifies the microscopic peaks and valleys on a metal surface, with lower values indicating a smoother finish that is highly resistant to soil adhesion.

102. (A) 0.8 micrometers
Sanitary standards establish strict limits for surface roughness. To prevent bacterial adhesion and ensure effective cleaning, product-contact surfaces in dairy equipment must maintain a maximum R_a value of 0.8 micrometers. This smooth finish minimizes microscopic crevices where soil and microorganisms can find harbor, ensuring complete sanitation during cleaning-in-place cycles.

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103. (D) AISI 304
AISI 304 is the standard grade of stainless steel specified for general dairy applications. This austenitic steel contains chromium and nickel, providing excellent resistance to corrosion from milk and mild cleaning chemicals. Its high durability, ease of welding, and ability to be

ions like calcium and magnesium. This chemical binding prevents these ions from reacting with other cleaning components, thereby preventing scale formation and enhancing overall detergent effectiveness in hard water.

28. (C) Foam causes pump cavitation, reducing fluid velocity needed for mechanical cleaning
Generating excess foam during automated cleaning-in-place cycles compromises mechanical cleaning. Foam introduces pockets of air into the return lines, leading to severe centrifugal pump cavitation. This cavitation disrupts liquid flow, reduces pressure, and drastically drops fluid velocity below the critical threshold required for turbulent scrubbing, leaving portions of the pipeline uncleaned.

29. (D) Sequestration keeps minerals soluble, while precipitation forms insoluble settling particles
Managing hard water minerals can be achieved through different chemical pathways. Sequestration utilizes specialized chemicals to bind calcium and magnesium ions into soluble ring complexes, keeping them dissolved and inactive. In contrast, precipitation causes these metal ions to react with carbonates or hydroxides, forming solid, insoluble mineral particles that settle out and form scale.

30. (C) Amphiphilic
Surfactant molecules are defined by their dual chemical affinity. They are amphiphilic, containing both a hydrophilic, polar head group that is highly soluble in water, and a hydrophobic, non-polar hydrocarbon tail that avoids water. This dual nature allows them to align at oil-water interfaces, lowering interfacial tension and facilitating soil removal.

31. (B) Alkaline sodium hydroxide
High-alkalinity detergents are required to dissolve heavy organic soils. Sodium hydroxide, or caustic soda, is the primary active ingredient in heavy-duty dairy cleaning-in-place formulations. It provides the high concentration of hydroxyl ions necessary to hydrolyze proteins, saponify fats, and maintain a high pH, ensuring rapid dissolution of tenacious milk deposits from heated surfaces.

32. (D) They provide corrosion inhibition for soft metals like aluminum
Strong alkaline solutions can be highly corrosive to sensitive materials. Sodium metasilicate is incorporated into dairy detergents to serve as a corrosion inhibitor for soft metals, such as aluminum and copper. Silicates form a protective, microscopic film over these metal surfaces, preventing chemical attack by hydroxyl ions while still allowing effective alkaline cleaning.

33. (B) I and II
Alkaline detergents rely on synergistic chemical components to clean dairy systems. Sodium hydroxide provides strong active alkalinity to peptize and hydrolyze protein films. Polyphosphates serve as sequestering agents, binding calcium and magnesium to prevent hard water mineral scale. However, EDTA functions strictly as a chelating agent, rather than performing saponification of fats.

34. (C) They revert to orthophosphates at high temperatures, losing sequestering power
Polyphosphates are effective water-conditioning agents but suffer from thermal instability. At elevated pasteurization and sterilization temperatures, these complex molecules undergo rapid hydrolysis, reverting to simple orthophosphates. This chemical reversion destroys their ability to sequester calcium and magnesium ions, often leading to the unintended precipitation of insoluble calcium phosphate scale on hot equipment plates.

35. (A) It has lower buffering capacity and active alkalinity for heavy soil removal
Sodium carbonate is widely used as a builder but is a weak alkaline agent compared to sodium hydroxide. It does not fully dissociate to yield the high concentration of hydroxyl ions required for hydrolyzing denatured whey proteins. Its limited buffering capacity makes it unsuitable for removing heavy, thermally baked-on organic soils in pasteurizers.

36. (D) Ethylenediaminetetraacetic acid (EDTA)
High-temperature alkaline cleaning requires stable chelating agents. Ethylenediaminetetraacetic acid is a powerful, hexadentate chelator that remains chemically stable at high pH and elevated temperatures. It effectively binds calcium and magnesium ions, preventing mineral scale formation during caustic wash cycles and

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converting insoluble fats into glycerol and free fatty acids that are easily rinsed from the system.

114. (C) Mineral components (calcium phosphates) in milk stone cannot be degraded by proteases or lipases
Traditional bio-detergents face limitations when cleaning thermal equipment. The high-temperature milk stone deposited in pasteurizers contains a significant mineral fraction, primarily calcium phosphate, which cannot be broken down by organic enzymes like proteases or lipases. Consequently, these systems still require acid washes to dissolve the inorganic mineral scale.

115. (A) II and V
Eradicating biofilms requires a detailed understanding of their structure. Biofilms protect bacteria within an extracellular polymeric substance matrix that standard chlorine sanitizers cannot easily penetrate. Enzymatic formulations can degrade this matrix to expose the bacteria. However, chlorine does not easily dissolve mature matrices, and proteases alone cannot remove inorganic mineral deposits.

116. (C) They are easily deactivated by the extreme pH and high temperatures of traditional CIP
Enzyme-based cleaning solutions contain biological catalysts that are highly sensitive to their environmental conditions. Standard sanitation protocols in dairy processing regularly utilize temperatures exceeding seventy degrees Celsius alongside strongly acidic or alkaline chemical agents. These extreme operating conditions rapidly denature the delicate protein structures of enzymes, causing complete loss of catalytic activity.

117. (A) By hydrolyzing peptide bonds, breaking insoluble proteins into soluble peptides
Proteases are specialized proteolytic enzymes that target proteinaceous soils, which are highly prevalent in dairy processing environments. These enzymes specifically catalyze the cleavage of peptide bonds holding amino acid chains together. By breaking down complex, insoluble macromolecules into smaller, highly soluble peptides and amino acids, the soil is easily suspended and rinsed away during cleaning.

118. (D) Polysaccharides, proteins, and extracellular DNA
The extracellular polymeric substance matrix of a biofilm functions as a protective physical barrier for embedded microbial communities. This complex organic structural network is primarily synthesized by the bacteria themselves and is composed of macromolecules including polysaccharides, structural proteins, and extracellular deoxyribonucleic acid. Effectively degrading these key components is essential for successful sanitizer penetration.

119. (B) 40 to 50 degrees Celsius
Commercial enzymes used in bio-detergents require moderate thermal conditions to achieve optimal kinetic velocity without undergoing rapid denaturation. Maintaining temperatures within the range of forty to fifty degrees Celsius maximizes the reaction rate of these biological catalysts. This specific range is also sufficiently low to prevent the thermal coagulation of sensitive dairy proteins onto surfaces.

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120. (C) P-3, Q-4, R-2, S-1
Enzymatic cleaning agents exhibit strict substrate specificity in dairy applications. Proteases specifically target peptide bonds in denatured whey proteins like beta-lactoglobulin. Lipases catalyze the hydrolysis of triglycerides into glycerol and fatty acids. Amylases are responsible for breaking down starch-based residues from formulated products, while lactase enzymes are utilized to cleave lactose into simple sugars.

121. (D) Biochemical Oxygen Demand (BOD)
Biochemical Oxygen Demand is a critical environmental indicator that quantifies the amount of dissolved oxygen consumed by aerobic microorganisms during the biological degradation of organic matter in wastewater. This standard parameter specifically evaluates the biodegradable portion of the effluent load over a defined incubation period, which is typically five days in regulatory testing.

122. (A) COD measures both biodegradable and chemically oxidizable organic substances
Chemical Oxygen Demand values are consistently higher than Biochemical Oxygen Demand values because of the comprehensive nature of chemical oxidation. While biological assays only measure substances readily degradable by living

microorganisms, chemical oxidation utilizing strong reagents under acidic conditions oxidizes nearly all organic matter present, including non-biodegradable, chemically oxidizable components that bacteria cannot degrade.

123. (B) Milk fat and lactose from product losses
The primary drivers of high Biochemical Oxygen Demand in dairy processing effluents are raw and processed product losses. Organic substances such as milk fat, proteins, and lactose represent highly concentrated biological nutrients. When discharged into wastewater streams, these compounds undergo intense microbial decomposition, which consumes substantial amounts of dissolved oxygen and elevates overall effluent strength.

124. (B) Fat, Oil, and Grease
In wastewater characterization, the abbreviation FOG represents fat, oil, and grease, which are major components of dairy processing waste. These lipids originate primarily from milk processing, butter production, and cheese manufacturing operations. Monitoring and removing these hydrophobic organic compounds is essential to prevent system clogging and to avoid serious interference with biological treatment processes.

125. (A) Due to batch discharges of strongly alkaline and acidic CIP solutions
The characteristic pH instability observed in dairy plant effluents is primarily driven by clean-in-place operations. CIP cycles generate periodic, concentrated discharges of highly alkaline sodium hydroxide solutions alongside highly acidic nitric or phosphoric acid washes. These distinct sanitation phases result in rapid, severe shifts in raw wastewater pH unless effective equalization and neutralization are implemented.

126. (C) Coagulated proteins, cheese curd fines, and insoluble fats
Total Suspended Solids in dairy wastewater represent the insoluble particulate matter that remains suspended in the liquid phase. This fraction is dominated by physical cheese curd fines, coagulated milk proteins, and insoluble fat droplets escaping from various processing lines. These solid materials must be physically separated during primary treatment to protect downstream biological reactors.

127. (D) COD test
The Chemical Oxygen Demand test is an analytical method that utilizes potassium dichromate as a highly powerful chemical oxidizing agent under strongly acidic conditions. This reaction is conducted at elevated temperatures to ensure the near-complete oxidation of both biodegradable and non-biodegradable organic compounds, providing a rapid estimation of the total chemical oxygen requirement.

128. (C) Approx. 100,000 mg/L
Whole raw milk contains exceptionally high concentrations of proteins, lipids, and carbohydrates, making it an extremely potent organic substance. Consequently, raw milk exhibits an average five-day Biochemical Oxygen Demand of approximately one hundred thousand milligrams per liter. Even minor product losses or spills can therefore exert an immense biological oxygen demand on wastewater treatment plants.

129. (B) It coats biological sludge, inhibiting oxygen transfer and settleability
Elevated levels of fat, oil, and grease pose significant operational challenges to aerobic biological treatment systems. When these hydrophobic substances enter aeration basins, they coat the biological sludge flocs. This physical coating creates a barrier that severely inhibits vital oxygen transfer to the bacteria and impairs the gravity settling characteristics of the sludge in clarifiers.

130. (D) Weigh filter paper, filter sample, dry filter paper at 103-105 degrees Celsius, weigh again
The standard analytical procedure for determining Total Suspended Solids requires weighing a clean glass-fiber filter paper first. A measured volume of raw wastewater is then drawn through this filter. The filter containing the captured solid residues is subsequently dried in an oven at 103 to 105 degrees Celsius to constant mass, then weighed again to calculate solids.

131. (A) Less than 30 mg/L
Environmental protection authorities enforce strict limits on treated wastewater discharges to prevent eutrophication and oxygen depletion in aquatic ecosystems. For direct discharge into inland surface waters like rivers and streams, the generally accepted maximum limit for Biochemical Oxygen Demand is less than thirty

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milligrams per liter. Achieving this level requires robust biological treatment.

132. (C) To buffer extreme variations in flow rate, pH, and organic load
Dairy processing operations are highly dynamic, generating effluent with highly variable characteristics. The fundamental purpose of an equalization basin is to collect these fluctuating flows, providing physical buffering that homogenizes variations in flow rates, pH levels, and organic concentration loads. This continuous blending ensures a stable, consistent feed to downstream biological treatment systems.

133. (A) It slows flow, allowing less dense fats to float and be skimmed off
Gravity fat traps utilize density differences to separate free lipids from wastewater streams. By significantly slowing the hydraulic flow rate, these passive physical chambers allow buoyant fats, oils, and greases, which have a lower specific gravity than water, to float upwards to the surface. Once accumulated at the top, they are mechanically skimmed off.

134. (D) Dissolved Air Flotation
In primary wastewater treatment, the acronym DAF stands for Dissolved Air Flotation. This widely utilized physicochemical separation process removes suspended solids, fats, oils, and greases by dissolving air under pressure into the liquid. When released at atmospheric pressure, microscopic air bubbles form, attaching to particles and carrying them to the surface for removal.

135. (B) Microscopic air bubbles attach to solids and fats, floating them to the surface
Dissolved Air Flotation functions by introducing pressurized water saturated with air into raw effluent. Upon releasing the hydraulic pressure inside the tank, millions of microscopic bubbles nucleate and rise. These micro-bubbles physically attach to suspended solids and emulsified fats, reducing their apparent density and floating them to the liquid surface to form a sludge blanket.

136. (C) Coagulants like ferric chloride combined with polymeric flocculants
To optimize contaminant removal in a Dissolved Air Flotation unit, chemical pre-treatment is routinely applied. Chemical coagulants, such as ferric chloride, are added to neutralize the negative electrical charges on suspended organic colloids, allowing them to aggregate. Polymeric flocculants are subsequently introduced to bind these tiny particles into larger, stable flocs that readily capture bubbles.

137. (D) Rotary drum screens or static fine screens
Mechanical screening represents the initial physical barrier in wastewater treatment headworks. Devices such as rotary drum screens or static fine screens are deployed at the raw effluent inlet to capture large, coarse debris, packaging scraps, and major cheese curd clumps. Removing these solids prevents mechanical blockages in pipes and protects downstream pumps from damage.

138. (A) Microorganisms are sensitive to pH shocks; pre-neutralization protects the biomass
Biological treatment processes rely on sensitive microbial communities that function optimally within a narrow, near-neutral pH range. Introducing raw, unbuffered wastewater containing extreme pH spikes directly into a bioreactor would shock and kill the active biomass. Neutralizing the effluent in the equalization basin beforehand buffers these chemical shocks, thereby protecting biological system stability.

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139. (B) It is sent to a holding tank for dewatering or anaerobic digestion
The concentrated skimming layer collected from the top of a DAF unit contains high levels of fats, coagulated proteins, and chemical polymers. This organic sludge cannot be discharged directly into the environment. Instead, it is pumped to a sludge holding tank, where it is prepared for mechanical dewatering or diverted into anaerobic digesters for recovery.

140. (B) II and III
Primary wastewater treatment processes serve distinct physical and chemical functions. Simple physical fat traps utilize gravity to separate insoluble lipids but are incapable of removing highly soluble organic compounds like lactose. Equalization basins provide essential load balancing, while chemical coagulants added before flotation destabilize negatively charged colloidal particles, facilitating their aggregation into buoyant flocs.

cardboard boxes and low-density polyethylene films, directly back into the production cycle. This process is known as material recycling and upcycling. Utilizing these recycling streams minimizes raw resource extraction, decreases greenhouse gas emissions, and significantly diverts solid waste away from municipal landfills.

160. (B) I
Dairy sludge generated from biological treatment processes is a highly organic, non-toxic material and is therefore not categorized as hazardous waste. In contrast, mechanical dewatering processes significantly reduce sludge moisture, substantially lowering transportation costs. Furthermore, composting serves as a highly effective stabilization method, and recycling uncontaminated packaging waste remains a vital sustainability strategy.

161. (B) DAF sludge contains high levels of long-chain fatty acids that inhibit methanogens
Anaerobic digestion of primary Dissolved Air Flotation sludge is chemically challenging due to its exceptionally high fat content. During digestion, these lipids hydrolyze to yield high concentrations of long-chain fatty acids. These compounds are strongly inhibitory to methanogenic archaea, coating bacterial cell membranes, restricting transport mechanisms, and causing severe foaming inside anaerobic digesters.

162. (D) Incineration
Incineration is a high-temperature thermal treatment process that involves the complete combustion of dried dairy sludge under highly oxidative conditions. This process effectively converts organic materials into flue gases, water vapor, and heat, reducing the final waste volume to a very small amount of sterile ash. This residue can then be safely landfilled.

163. (A) Filtered via ultrafiltration to recover Whey Protein Concentrate (WPC)
A highly efficient circular economy strategy in cheese manufacturing is the direct valorization of liquid whey using membrane filtration. Passing raw whey through ultrafiltration membranes allows for the concentration and recovery of valuable, functional whey proteins, producing whey protein concentrate. This process extracts premium nutritional ingredients while drastically reducing organic load in wastewater.

164. (C) A low-tech sand filter bed where sludge dries via solar evaporation and drainage
A sludge drying bed is a classic, low-tech physical dewatering facility commonly utilized in smaller wastewater plants. It consists of shallow containment areas containing layers of sand and gravel. Wet biological sludge is spread over the bed surface, where it dries through a combination of gravity drainage into underdrains and solar evaporation to the atmosphere.

165. (A) To systematically evaluate energy use, identify waste, and recommend savings
An energy audit is a systematic and detailed evaluation of energy flows within an industrial facility. In a dairy processing plant, the primary objective is to map energy consumption, identify specific areas of thermal or electrical waste, and recommend cost-effective conservation measures. This systematic approach lowers operating costs and reduces the overall carbon footprint.

166. (D) Steam for pasteurization and CIP heating
Within a fluid milk processing facility, thermal energy demands are significantly higher than electrical demands. The single largest consumer of thermal energy is the generation of steam, which is continuously required to heat milk during pasteurization and sterilization processes, and to heat massive volumes of chemical detergents in clean-in-place operations.

167. (B) Regenerative heat exchange between hot pasteurized and cold raw milk
Modern continuous pasteurizers achieve outstanding thermal efficiency by utilizing regenerative heat exchange. This engineering technique allows hot, newly pasteurized milk to transfer its heat energy directly to the incoming cold raw milk. This process simultaneously preheats raw milk and pre-cools pasteurized milk, reducing steam requirements and refrigeration loads by ninety-five percent.

168. (C) Poor heat transfer in the boiler, causing energy loss to the air
During a thermal energy audit of a boiler, elevated flue gas temperatures serve as a primary indicator of operational inefficiency. This thermal condition indicates poor heat transfer from combustion gases to the boiler water, which is often caused by soot accumulation on the fire side or mineral scale buildup on the water tubes.

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150. (A) Both A and R are true and R is the correct explanation of A
Anaerobic treatment processes yield substantially less excess biological sludge than aerobic processes because of differing metabolic pathways. Anaerobic microorganisms obtain much less energy from degrading organic molecules, directing the majority of carbon substrates toward the production of gaseous methane and carbon dioxide. This metabolic behavior results in minimal conversion into new bacterial cell mass.

151. (B) Settleable anaerobic sludge granules
The retention of high concentrations of active biomass within a UASB reactor is facilitated by the natural formation of dense sludge granules. These heavy biological aggregates consist of highly organized consortia of anaerobic bacteria and methanogenic archaea. Their excellent gravity settling properties prevent them from being washed out, eliminating the need for physical supports.

152. (C) Proliferation of filamentous bacteria preventing sludge floc compaction
Sludge bulking is a serious operational malfunction in activated sludge clarifiers that is primarily triggered by the excessive growth of filamentous bacteria. These thread-like organisms extend beyond the boundaries of biological flocs, physically preventing them from compacting and settling properly. This results in poor gravity separation, a high sludge volume index, and biomass carryover.

153. (D) Dissolved Oxygen (DO) levels between 1.5 and 2.0 mg/L
To maintain efficient microbial metabolism and organic degradation within an activated sludge aeration tank, dissolved oxygen levels must be precisely regulated. Operators typically maintain DO concentrations between 1.5 and 2.0 milligrams per liter. This specific range provides sufficient oxygen to support bacterial respiration while avoiding excessive energy consumption from aeration blower operation.

154. (A) Sludge thickening to reduce water content and volume
Waste Activated Sludge removed from biological systems initially contains an extremely high water content, often exceeding ninety-nine percent by mass. The first step in handling this waste is sludge thickening, which utilizes gravity or flotation to separate free water. This initial process significantly reduces the physical volume of sludge before downstream dewatering steps.

155. (B) Decanter centrifuge
Decanter centrifuges are highly efficient mechanical systems used in dairy facilities for rapid sludge dewatering. These devices apply immense centrifugal forces to continuously separate the dense solid biological cake from the lighter liquid water phase. This mechanical process produces a highly concentrated cake with minimal water content, which dramatically lowers waste disposal costs.

156. (B) To enhance flocculation for easier separation of water and solids
Applying polymer coagulants to biological sludge before it undergoes dewatering is critical for flocculation. These chemical polymers bind small, dispersed biological particles together, forming much larger and structurally stable flocs. This aggregation process releases bound water from the organic matrix, enabling rapid and efficient physical separation of liquid and solids in dewatering machinery.

157. (A) Land application as an organic soil conditioner and fertilizer
Dewatered and biologically stabilized dairy sludge is rich in organic carbon, nitrogen, and phosphorus. Because of this beneficial nutrient profile, a highly common and ecologically sustainable method of final disposal is land application. It acts as an effective soil conditioner and natural fertilizer, returning vital nutrients to agricultural soils and supporting crop growth.

158. (C) Segregated into dry waste bins and sent to a landfill or recycling facility
Solid wastes generated from floor sweeping, such as plastic wrappers, plastic caps, and hairnets, are completely non-biodegradable. These items must never be flushed down drains, as they damage pumps and clog screens. Proper environmental management requires segregating these materials into dry waste bins and routing them to dedicated landfills or industrial recycling facilities.

159. (D) Upcycling and material recycling
The circular economy model promotes returning clean, uncontaminated packaging waste, including

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141. (A) They cannot remove soluble organic loads or emulsified fats
Mechanical screens are designed exclusively for primary physical separation of coarse particulate matter. Their main limitation is that they are entirely unable to remove soluble organic substances, such as dissolved lactose and whey proteins, or finely emulsified fat droplets. These highly concentrated dissolved pollutants pass directly through screen apertures and require subsequent biological treatment.

142. (C) To prevent solids from settling and maintain aerobic conditions to avoid odors
Installing submerged mixers or air diffusers within an equalization basin is crucial for two operational reasons. Continuous agitation prevents solid particulates, such as curd fines, from settling and accumulating on the basin floor. Simultaneously, introducing oxygen maintains aerobic conditions, preventing anaerobic fermentation of milk sugars, which would otherwise generate highly offensive odors.

143. (D) Activated Sludge Process (ASP)
The Activated Sludge Process is a widely applied biological wastewater treatment technology that relies on suspended growth. In this aerobic system, a diverse community of active microorganisms is maintained in suspension within an aeration tank. These aerobic bacteria continuously consume and metabolize dissolved organic pollutants, transforming them into carbon dioxide, water, and biomass.

144. (C) To separate active biomass from treated water via gravity settling
In an Activated Sludge Process, the secondary clarifier acts as a passive gravity settling basin situated directly downstream of the aeration tank. Its primary engineering function is to separate the suspended biological flocs from the treated liquid effluent. This process allows clarified water to overflow, while the settled biomass is collected at the bottom.

145. (B) Settled biomass returned to the aeration tank to maintain microbial levels
Return Activated Sludge is the concentrated biomass recovered from the bottom of the secondary clarifier and recycled back to the inlet of the aeration tank. Returning this active microbial mass is essential to maintain a sufficiently high concentration of degradative bacteria, which ensures the continuous, efficient treatment of incoming raw organic pollutants.

146. (D) It is an attached growth biofilm process on solid media rather than a suspended growth process
While the Activated Sludge Process maintains active microbes in suspension, a Trickling Filter is an attached growth biological process. In this system, wastewater is distributed over a bed of highly porous solid media, such as stones or plastic shapes. Microorganisms colonize these surfaces, forming a biological biofilm that metabolizes the organic contaminants as they trickle.

147. (A) Upflow Anaerobic Sludge Blanket (UASB) reactor
The Upflow Anaerobic Sludge Blanket reactor is a highly efficient anaerobic system optimized for treating highly concentrated organic wastewater streams, such as cheese whey. Wastewater flows upward through a dense, suspended blanket of active anaerobic granular sludge. This high-rate configuration allows for rapid biochemical degradation of concentrated dairy sugars and proteins without mechanical aeration.

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148. (C) Biogas composed of methane and carbon dioxide
During anaerobic digestion inside a UASB reactor, complex organic pollutants are converted by methanogenic archaea into a valuable energy-rich biogas. This generated gaseous by-product consists primarily of methane and carbon dioxide. Dairy facilities can capture this clean biogas and burn it in plant boilers, significantly reducing their reliance on fossil fuels and lowering costs.

149. (A) Anaerobic systems cannot achieve the low BOD levels needed for final discharge
Anaerobic treatment systems are highly efficient at reducing massive organic loads, but their effluent typically retains residual organic pollutants, ammonium, and sulfides. Consequently, these systems alone cannot achieve the extremely low BOD limits mandated for direct environmental discharge. A downstream aerobic polishing step is required to thoroughly oxidize remaining contaminants and stabilize the water.

169. (D) Installing Variable Frequency Drives (VFDs) on compressor motors
Refrigeration systems represent a massive electrical load in dairy processing. To optimize this energy consumption, installing Variable Frequency Drives on compressor motors is highly effective. VFDs modulate the rotational speed of the compressor to precisely match fluctuating refrigeration demand, preventing continuous, inefficient full-speed operation and significantly reducing peak electrical draw.

170. (A) Installing capacitor banks
A low power factor in a dairy plant is typically caused by numerous inductive loads, such as large electric motors running pumps. Installing capacitor banks at the electrical service entrance is the standard corrective solution. Capacitors supply necessary reactive power locally, which increases the power factor closer to unity and reduces utility penalties.

171. (B) Undetected leaks in the distribution piping and fittings
Compressed air generation is highly energy-intensive and represents a costly industrial utility. The most common source of severe energy waste in these systems is undetected physical leaks in the extensive distribution piping, joints, and connections. Implementing routine leak detection and repair programs is highly recommended to restore system pressure and save electricity.

172. (B) It recovers high-temperature water, saving both fuel and water treatment chemicals
Recovering and returning hot steam condensate to the boiler feed tank is a highly effective heat-recovery practice. Because condensate consists of high-purity, pre-heated water, reusing it directly saves substantial boiler fuel that would otherwise be required to heat cold makeup water. Additionally, this practice drastically minimizes fresh water consumption and chemical costs.

173. (A) It reduces heat loss from steam pipes and heat gain into chilled lines
Thermal insulation plays a critical role in maintaining the overall energy efficiency of a dairy processing plant. Applying high-performance insulation materials around steam and hot water piping minimizes radiant heat loss. Conversely, insulating chilled water and glycol lines prevents ambient heat gain, which significantly reduces the work load on both boilers and refrigeration chillers.

174. (C) Specific Energy Consumption (e.g., energy consumed per liter of milk processed)
Specific Energy Consumption is the primary key performance indicator calculated during dairy energy audits to benchmark facility efficiency. SEC is determined by dividing the total thermal and electrical energy consumed over a given period by the total volume of milk processed. This ratio allows managers to track efficiency trends and compare plant performance.

175. (D) P-4, Q-3, R-2, S-1
Systematic utility auditing focuses on specific target solutions to achieve maximum energy savings. Steam systems require repairing faulty steam traps and improving pipeline insulation. Electrical motor efficiency is optimized by installing Variable Frequency Drives. Refrigeration systems benefit from raising suction pressures, while compressed air systems are improved by fixing leaks and lowering pressure.

176. (C) Quantifying total fresh water consumed directly and indirectly per unit of product
Establishing a water footprint metric allows a dairy processing facility to comprehensively evaluate its water use sustainability. This environmental metric quantifies the total volume of fresh water consumed both directly during internal plant operations and indirectly throughout the product lifecycle to manufacture a single unit of finished dairy product, identifying critical targets for conservation.

177. (B) 1 to 2 liters of water per liter of milk processed
Optimizing water efficiency is a key operational objective for modern, sustainable dairy processing facilities. While older, inefficient plants may consume up to five liters of water per liter of milk, well-optimized modern facilities successfully reduce this specific water consumption ratio to between one and two liters of water per liter of milk.

178. (D) Condensate reclaimed from milk or whey evaporation that can be reused in the plant
In the dairy industry, the term cow water refers to the pure water vapor evaporated and subsequently condensed during the

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concentration of liquid milk or whey. This high-volume condensate can be reclaimed, polished, and safely reused within the processing plant for non-potable applications, such as cooling tower makeup, boiler feed water, or CIP pre-rinsing.

179. (A) Using recovered final clean rinse water as the pre-rinse for the next CIP cycle
Automated clean-in-place systems offer significant opportunities for direct water conservation through water recovery loops. A highly effective strategy involves capturing clean water from the final rinse of a completed CIP cycle and storing it in a recovery tank. This recovered water is then utilized as the pre-rinse for the next CIP sequence, saving water.

180. (B) I, III, IV and V
Implementing comprehensive water conservation strategies in a dairy plant involves multiple Good Manufacturing Practices. Using high-pressure, low-volume spray nozzles and automating CIP systems drastically reduces manual wash water consumption. Furthermore, recovering hot boiler condensate conserves both thermal energy and water, while dry sweeping floors before hosing down prevents excessive solid waste water loading.

181. (A) It contains high concentrations of chemical biocides, anti-scaling agents, and minerals
Reusing cooling tower blowdown water directly for cleaning food-contact equipment is strictly prohibited due to chemical contamination risks. To maintain cooling efficiency, tower water is treated with biocides, anti-scaling chemicals, and corrosion inhibitors. These toxic non-food-grade chemicals, along with concentrated dissolved minerals, would contaminate product-contact surfaces and compromise dairy food safety.

182. (D) Feeding the primary boilers or cooling tower makeup water
Effluent water that has been thoroughly treated and polished using advanced Reverse Osmosis membrane systems is of extremely high chemical purity. To ensure food safety, this reclaimed water is typically restricted to high-volume, non-product-contact utility applications. Highly common and safe destinations include supplying make-up water for cooling towers or feeding steam boilers.

183. (B) They shut off the flow automatically when dropped, preventing continuous water waste
Manual washdown operations represent a major source of uncontrolled water consumption in dairy facilities. Installing automatic spring-loaded trigger nozzles on all manual cleaning hoses provides immediate conservation. These devices ensure that the water flow is instantly shut off the moment the operator releases the handle or drops the hose, preventing freshwater waste.

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184. (C) Accounting for all incoming fresh water and balancing it against outgoing effluent, product, and losses
In industrial water auditing, establishing a water mass balance is a fundamental analytical step. This process involves systematically accounting for all volumes of incoming fresh water from municipal and underground sources, then mathematically balancing them against outgoing streams, including water incorporated into finished products, wastewater discharge, evaporation losses, and unexplained system leaks.

185. (D) Trace organic carryover that can support rapid microbial growth in storage tanks
Reclaiming and storing Cow Water without implementing advanced secondary sanitization, such as ultraviolet irradiation or chemical dosing, introduces significant microbiological risks. The condensate often carries over trace volatile organic compounds and nutrients from milk concentration processes. These organic residues accumulate in storage vessels, acting as a substrate that supports rapid bacterial proliferation.

186. (A) The rinsing phases (pre-rinse and final rinse)
In a traditional clean-in-place sequence, the water rinsing phases, specifically the pre-rinse and the final clean rinse, consume the absolute highest volume of fresh water. The pre-rinse is designed to physically flush out loose milk residues, while the final rinse removes remaining chemicals. Consequently, these phases are primary targets for water-recovery optimization.

187. (B) All wastewater is purified and recycled, resulting in zero liquid leaving the site boundaries
Zero Liquid Discharge is an advanced waste management strategy designed to eliminate all liquid emissions from an industrial facility.

Under a ZLD scheme, all wastewater generated within the dairy processing plant is intensively purified and completely recycled back into plant utilities. This closed-loop configuration ensures that absolutely no liquid waste is discharged off-site.

188. (B) Reverse Osmosis (RO) membranes
The core separation technology utilized to achieve high-purity water recovery in ZLD systems is Reverse Osmosis. Pressurized wastewater is forced through semi-permeable RO membranes, which successfully separate clean, reusable water permeate from dissolved inorganic salts, minerals, and trace organic molecules. The highly purified permeate is then recycled, while the concentrated reject stream undergoes treatment.

189. (A) It is sent to evaporators and crystallizers to reduce it to dry solids for disposal
In a comprehensive Zero Liquid Discharge system, the highly concentrated brine reject generated by Reverse Osmosis processes cannot be discharged. Instead, this stream is directed to thermal evaporators and crystallizers. These energy-intensive systems evaporate the remaining water, converting the dissolved salts and minerals into dry solid residues that can be safely landfilled.

190. (B) IV, I, II, III
Achieving complete Zero Liquid Discharge requires a highly structured sequence of wastewater treatment phases. The process begins with primary treatment, including screening and DAF, to remove coarse solids and lipids. Next, biological reactors degrade dissolved organics. The polished effluent is then treated via Reverse Osmosis, and the resulting brine reject is evaporated and crystallized.

191. (D) High capital costs and massive energy consumption required to evaporate the RO reject brine
The primary economic barrier preventing the widespread adoption of complete ZLD systems is the substantial financial investment required. Installing high-capacity Reverse Osmosis systems, thermal evaporators, and crystallizers demands massive upfront capital. Furthermore, operating thermal systems to evaporate the highly concentrated brine reject consumes extreme amounts of electrical and steam energy, increasing operating expenses.

192. (C) Mixed inorganic salts that can be used in agricultural or industrial applications
Beyond pure recycled water, the crystallization phase of a Zero Liquid Discharge system generates solid mineral by-products. This process recovers concentrated mixtures of inorganic salts, primarily sodium, potassium, chlorides, and sulfates, from the wastewater stream. These recovered dry salts can be valorized and sold for use in specific agricultural formulations or industrial manufacturing applications.

193. (B) Anaerobic digestion of organic sludge into biomethane to fuel plant boilers
A circular zero-waste approach aims to divert all organic by-products from disposal. In dairy facilities, sending biological sludge to anaerobic digestion systems exemplifies this model. Anaerobic bacteria break down the organic solids to generate biomethane gas, which is captured and burned directly in the plant's boilers to produce steam, closing the energy loop.

194. (D) To remove suspended solids and macromolecules that would immediately foul the fine RO membranes
Reverse Osmosis membranes possess microscopic pores that are highly vulnerable to physical and biological fouling. If raw, treated biological effluent were fed directly into RO units, remaining suspended solids, colloids, and macromolecules would rapidly accumulate on membrane surfaces. Implementing robust physical pre-treatment, such as ultrafiltration, removes these foulants, ensuring sustained membrane performance and longevity.

195. (A) Strict regulations on effluent discharge coupled with local freshwater scarcity
Dairy processing facilities located in arid geographic regions face compounding environmental challenges. Severe local freshwater scarcity limits the volume of water plants can extract, while regulatory authorities enforce increasingly strict limits on liquid waste discharges. These factors drive the adoption of Zero Liquid Discharge systems, enabling factories to secure their water supply by recycling.

196. (C) It lacks buffering capacity and dissolved minerals, making it highly corrosive and requiring chemical conditioning
Polished Reverse Osmosis permeate is highly demineralized and completely lacks dissolved

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ions. This mineral depletion results in water with zero buffering capacity, making it aggressively corrosive to carbon steel boiler systems. Before this purified water can be safely fed into boilers, it must undergo chemical conditioning to adjust pH levels and add inhibitors.

197. (A) Forward Osmosis and Membrane Distillation
Traditional thermal evaporation of high-salinity brine reject is highly energy-intensive. To improve ZLD efficiency, alternative membrane-based technologies are emerging as viable options. Forward Osmosis and Membrane Distillation utilize natural osmotic pressure gradients or waste heat to drive water separation across membranes, reducing the electrical and steam demand compared to standard thermal evaporators.

198. (D) Good Manufacturing Practices
In the context of food safety and dairy operations management, the abbreviation GMP represents Good Manufacturing Practices. This is a foundational quality assurance program consisting of structured guidelines and operational standards. Implementing these practices ensures that dairy products are consistently manufactured, handled, and controlled under sanitary conditions to meet strict safety standards.

199. (B) To prevent biological, chemical, or physical product contamination by workers
The primary objective of implementing Good Hygiene Practices among dairy facility personnel is to prevent the introduction of biological, chemical, or physical hazards into food products. Because human handlers are natural vectors for pathogens and foreign bodies, strict GHP compliance ensures that employee behavior, handwashing, and clothing do not compromise product safety.

200. (C) They pose physical hazards if lost, and they harbor bacteria, hindering handwashing
Personal jewelry, including rings, watches, and necklaces, is strictly prohibited within dairy processing areas for critical safety reasons. These items represent significant physical hazards, as they can loosen and fall directly into open food products. Furthermore, jewelry contains microscopic crevices that harbor pathogenic bacteria and physically obstruct thorough handwashing and sanitization protocols.

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201. (A) Both A and R are true and R is the correct explanation of A
Restricting the movement of dairy personnel between raw milk receiving areas and post-pasteurization packaging zones is a vital food safety measure. Raw milk zones naturally harbor environmental pathogens like Listeria monocytogenes. Preventing personnel from crossing directly between these areas eliminates a major cross-contamination pathway, protecting pasteurized, ready-to-eat finished products from recontamination.

202. (A) Using dedicated sanitary boots sanitized via a boot-wash or footbath before entry
Footwear is a primary vector for transmitting pathogenic microorganisms across dairy processing floors. Good Manufacturing Practices mandate that personnel in high-care zones wear dedicated sanitary boots that never leave the facility. These boots must be systematically cleaned and sanitized using automated boot-washers or chemical footbaths before entering any production area.

203. (B) The employee has gastrointestinal symptoms or open, infected skin wounds
Personnel suffering from active gastrointestinal symptoms, such as vomiting and diarrhea, or possessing open, infected skin wounds must be immediately excluded from food handling duties. These biological conditions present extreme risks of transmitting pathogenic bacteria, such as Staphylococcus aureus, directly into dairy products, posing a major threat to public health.

204. (B) To allow blue metal-detectable dressings to be easily seen and caught by inline metal detectors
Brightly colored, metal-detectable adhesive dressings are a standard GMP requirement for personnel with minor cuts. These bandages are typically colored bright blue, which does not match any natural dairy product, allowing easy visual identification. Additionally, they contain an internal metallic strip that triggers inline metal detectors, preventing physical product contamination.

205. (A) At induction, and refreshed regularly or whenever procedures change
To maintain a robust food safety culture, comprehensive GMP and GHP training must be provided to all dairy plant personnel. This

essential education must occur immediately during employee induction and be refreshed through regularly scheduled training programs, or whenever processing equipment, operating procedures, or food safety regulations undergo significant modification.

206. (C) Step directly into the sanitizer, ensuring boot treads are submerged to kill pathogens
Footbaths at processing room entryways function as critical sanitary barriers. To ensure maximum disinfection efficacy, personnel must step directly into the sanitizing liquid, ensuring that the entire bottom and treads of their boots are fully submerged. This physical contact allows the active chemical sanitizer to penetrate tread crevices and kill tracked pathogens.

207. (D) It separates the plant into color-coded hygiene areas to restrict movement between raw and pasteurized zones
Hygienic zoning is a core physical contamination barrier that divides a dairy processing facility into distinct, color-coded risk areas. By establishing separate zones for raw milk receiving, processing, and final packaging, the plant restricts direct movement of personnel and tools. This structural segregation prevents environmental pathogens from crossing into high-hygiene areas.

208. (C) Identifying asymptomatic pathogen carriers that can contaminate food
Routine health screening for food handlers is a key preventive measure in dairy operations. The primary clinical focus of these evaluations is to identify asymptomatic carriers of communicable pathogens, such as Salmonella. Because these individuals can shed harmful microorganisms without exhibiting outward symptoms, screening prevents them from contaminating open product lines.

209. (B) Performing scheduled maintenance, lubrication, and parts replacement to prevent breakdowns
The core philosophy of a Preventive Maintenance system is to proactively manage equipment health before mechanical failures occur. Rather than reacting to breakdowns, PM relies on a structured schedule of routine inspections, cleaning, lubrication, and planned component replacements. This scheduled approach minimizes unplanned downtime, extends machine service life, and maintains consistent processing quality.

210. (D) Using vibration analysis sensors to detect early bearing wear before failure
Predictive maintenance utilizes advanced condition-monitoring technologies to evaluate equipment performance in real time during normal operation. For high-speed rotating machinery like dairy separators, using vibration analysis sensors is a hallmark technique. These sensors detect microscopic changes in rotational frequencies and structural vibrations, identifying early bearing wear and preventing catastrophic mechanical failure.

211. (A) Friction caused by bearing wear, poor lubrication, or seal degradation
During the condition monitoring of rotating machinery, an unexplained, sharp increase in operating temperature is a critical diagnostic sign. This thermal elevation indicates excessive friction generated within the moving components. It is commonly caused by premature bearing wear, insufficient or degraded lubrication, or physical degradation of internal mechanical seals, which requires immediate corrective action.

212. (C) The homogenization valve and high-pressure ceramic plungers
High-pressure homogenizers operate under extreme physical stresses to break down fat globules. The components subjected to the highest rates of mechanical wear and shear force are the homogenization valve assembly and the high-pressure ceramic plungers. Consequently, these critical parts require strict, regularly scheduled preventive maintenance inspections and timely replacements to avoid catastrophic failure.

213. (A) To detect thermal hot spots from loose connections or overloads before fires occur
Infrared thermography is a powerful non-destructive predictive maintenance tool used to evaluate electrical control panels in dairy plants. This technology detects localized thermal anomalies or hot spots, which typically indicate loose electrical connections, corroded contacts, or overloaded circuits. Identifying these issues early allows technicians to perform repairs before electrical fires or equipment failures occur.

214. (D) The pump will leak product externally or draw ambient air into the product stream
Neglecting the scheduled preventive maintenance of mechanical seals on sanitary centrifugal milk

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CHAPTER 13

Legal and Quality Management System for Milk and Milk Products

2008

1. Which of the following best defines the concept of milk quality in the dairy industry?
(A) The overall physical appearance, color, and viscosity of raw milk measured immediately after milking operations
(B) A combination of chemical, physical, and hygienic attributes meeting regulatory standards
(C) The precise laboratory measurement of fat, protein, and solid-not-fat contents within bulk raw milk
(D) The absolute and complete absence of any naturally occurring microorganisms or somatic cells in raw milk

2008

2. Which statement accurately describes a critical aspect of milk safety?
(A) It strictly pertains to maintaining high milk fat percentages and solids-not-fat parameters
(B) It requires all commercial dairy products to be sterilized at ultra-high temperatures daily
(C) It deals primarily with the aesthetic design and structural integrity of the outer packaging
(D) It involves preventing physical, chemical, and biological hazards to protect consumers

2017

3. Under standard hygiene practices, which is the most critical measure to prevent the initial biological contamination of raw milk at the farm level?
(A) Pre-milking teat dipping and proper udder sanitization
(B) Immediate homogenization of raw milk
(C) Addition of chemical preservatives immediately after milking
(D) Holding raw milk at room temperature before transport

2021

4. Which of the following parameters is NOT typically used to assess the primary keeping quality of raw milk?
(A) Titratable acidity
(B) Somatic cell count
(C) Lactose crystallization rate
(D) Methylene Blue Reduction Time (MBRT)

2013

5. Given below are two statements, one labeled as Assertion (A) and the other as Reason (R).
Assertion (A): Maintaining strict hygiene during milking significantly extends the keeping quality of raw milk.
Reason (R): Strict hygiene minimizes the initial bacterial load, thereby delaying the onset of lactic acid fermentation and spoilage.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

NODIA

2012

6. What is the primary purpose of employing the High-Temperature Short-Time (HTST) pasteurization technique in dairy hygiene?
(A) To completely eliminate all viable thermoduric bacteria and dormant bacterial spores
(B) To separate raw milk into concentrated cream and skim milk components effectively
(C) To denature functional whey proteins in order to artificially increase total cheese yield
(D) To destroy Coxiella burnetii, the most heat-resistant non-spore-forming pathogen in milk

2018

7. What is a major disadvantage of poor hygienic practices during the chilling phase of raw milk?
(A) Excessive physical crystallization and

223. (D) Use NSF H1 food-grade grease carefully to avoid over-greasing and dripping into product
When performing maintenance on equipment located directly above open processing vessels, such as cheese vats, technicians must exercise extreme caution. It is critical to utilize NSF H1 registered food-grade grease to protect against potential contamination. Additionally, the grease must be applied precisely to avoid over-lubrication, which can cause excess grease to drip into product.

224. (C) It must be ground smooth, polished, and chemically passivated to restore the chromium oxide layer
Modifying or re-welding stainless steel dairy equipment alters the metal's surface properties and disrupts its corrosion resistance. Post-weld treatment requires grinding the weld completely flush with the metal surface and polishing it to a sanitary finish. Finally, chemical passivation using acid solutions must be performed to restore the protective, passive chromium oxide layer.

225. (B) Engineers must use dedicated, sanitized tools and account for them to prevent foreign body contamination
Maintenance engineers operating on a dairy processing floor must adhere to strict sanitary tool control protocols. Technicians are required to use dedicated, pre-sanitized tools that are never utilized in non-food areas. Furthermore, a strict tool-accounting inventory must be completed before and after any maintenance event to prevent dangerous foreign body contamination in processing lines.

226. (D) Replace them with new O-rings lightly lubricated with food-grade grease to ensure a proper seal
Dismantling a sanitary centrifugal pump alters the compression and physical integrity of its elastomeric seals. Upon reassembly, best practice dictates replacing the old O-rings with brand new components. These new seals should be lightly lubricated using NSF H1 food-grade grease to facilitate correct seating, prevent pinching, and ensure a completely leak-free, hygienic seal.

227. (A) The system under-pasteurizes the milk because it reads too high, risking pathogen survival
If a temperature probe in a pasteurization system reads two degrees Celsius higher than the actual physical temperature, it introduces a severe food safety risk. The automated system will register the target pasteurization temperature as achieved when the milk is actually under-heated. This under-pasteurization fails to ensure complete pathogen destruction, potentially leaving active pathogens in products.

228. (C) The internal swirl chambers and tungsten carbide orifice inserts that suffer high friction
Spray dryer nozzle assemblies operate under extreme hydraulic pressures to achieve efficient liquid atomization. The components subjected to severe mechanical friction and erosion are the internal swirl chambers and the tungsten carbide orifice inserts. Routinely replacing these worn parts during sanitary maintenance is critical to prevent poor atomization, which can cause wet deposits and scorching.

229. (A) A smooth, full-penetration TIG weld flush with the inside pipe surface, free of crevices
In dairy piping networks, a sanitary weld is characterized as a smooth, full-penetration Tungsten Inert Gas weld. This specialized welding technique must yield an internal surface that is completely flush with the pipe walls, entirely free of crevices. This smooth finish ensures that CIP solutions can effectively clean and sanitize all internal piping surfaces.

NODIA

230. (D) ATP bioluminescence swabbing to instantly detect remaining organic cellular residue
ATP bioluminescence swabbing is a widely used rapid validation method deployed post-maintenance in dairy plants. This biological assay instantly detects the presence of adenosine triphosphate, an energy-carrying molecule found in all organic matter. Obtaining immediate cleanliness readings allows operators to verify complete soil removal before initiating the final sanitization phase of the system.

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pumps leads to immediate operational issues. Worn or damaged seals fail to maintain a tight barrier, causing valuable product to leak externally onto the floor. Conversely, under negative pressure, compromised seals allow ambient air to be drawn directly into the liquid milk stream, causing foaming.

215. (B) P-2, Q-4, R-1, S-3
Implementing targeted condition-monitoring techniques is essential for a comprehensive maintenance program. Vibration analysis is used to detect premature wear in high-speed separator bearings. Oil condition analysis monitors the degradation of heavy gearbox lubricants. Ultrasonic leak detection identifies micro-fissures in compressed air lines, while infrared thermography locates overloaded electrical contacts inside motor control centers.

216. (C) It tracks assets, schedules work orders, manages spare parts, and logs breakdowns
A Computerized Maintenance Management System is a vital software platform utilized to streamline dairy facility operations. CMMS software centrally tracks physical assets, automatically schedules routine preventive maintenance work orders, manages spare parts inventory levels, and logs historical machine breakdowns. This organized digital logging optimizes labor efficiency and reduces overall equipment downtime.

217. (D) Pressure testing and replacing plate gaskets before they become brittle and fail
To prevent critical cross-contamination between the raw and pasteurized milk streams within plate heat exchangers, rigorous preventive maintenance is required. Technicians must conduct periodic hydrostatic pressure testing to identify internal leaks. Additionally, systematically replacing elastomeric plate gaskets before they become brittle, lose elasticity, and fail is vital to maintain process integrity.

218. (A) To prevent violent vibrations at high RPM that cause catastrophic structural failure
Centrifugal clarifiers and separators in dairy plants operate at exceptionally high rotational speeds, often exceeding several thousand revolutions per minute. At these extreme velocities, maintaining precise dynamic balancing of the rotor bowl assembly is critical. Any minor weight asymmetry generates massive centrifugal forces, causing violent vibrations that can lead to catastrophic structural machine failure.

219. (B) Postponing maintenance until failure; acceptable only for low-cost, non-critical items
A run-to-failure strategy involves intentionally postponing all maintenance activities on a component until it completely breaks down. While this reactive approach is highly dangerous for critical processing machinery, it is appropriate and cost-effective for low-cost, non-critical dairy plant assets, such as office lighting, where failure does not compromise production capacity or personnel safety.

220. (B) Food-grade lubricants (NSF H1) are non-toxic, posing no hazard if incidental product contact occurs
The fundamental distinction between standard industrial and food-grade lubricants lies in their chemical formulation and toxicity profiles. Food-grade lubricants, specifically those holding NSF H1 registration, are formulated using strictly non-toxic ingredients. This safety profile ensures that if incidental, minor contact with a dairy product occurs, it poses absolutely no chemical or health hazard.

221. (A) The indicating thermometer and Safety Thermal Limit Recorder
In an HTST pasteurization system, the indicating thermometer and the Safety Thermal Limit Recorder represent critical control point instruments. These regulatory devices directly monitor and log the precise heat treatment of milk to ensure complete pathogen destruction. Consequently, they require systematic, legally mandated sanitary maintenance, verification, and calibration by certified technicians.

222. (C) They suffer cold flow, become brittle, and develop micro-cracks that harbor bacteria
Elastomeric hygienic seals, such as tri-clamp gaskets, must be replaced on a scheduled basis even if they show no signs of leaking. Over time, exposure to high temperatures and aggressive CIP chemicals causes polymers to undergo cold flow, become brittle, and develop microscopic surface cracks. These micro-fissures accumulate organic residues and harbor pathogenic bacteria.

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clumping of raw milk fat globules
(B) Proliferation of psychrotrophic bacteria producing heat-stable enzymes
(C) Spontaneous microbiological fermentation leading to instant kefir formation
(D) Accelerated structural degradation of essential fat-soluble vitamins

2011
8. Which of the following is an INCORRECT statement regarding the natural antimicrobial systems in fresh milk?
(A) The lactoperoxidase enzyme system exerts a strong bacteriostatic effect on bacteria
(B) Lactoferrin binds free iron, making it entirely unavailable to pathogenic bacteria
(C) These natural systems completely sterilize raw milk stored at room temperature
(D) Lysozyme actively breaks down the outer cell walls of Gram-positive bacteria

2023
9. High Somatic Cell Counts (SCC) in milk are primarily an effect of which of the following causes?
(A) Improper cooling of raw milk immediately after extraction
(B) Adulteration of milk with chemical urea and synthetic detergents
(C) Extended holding times of raw milk in farm bulk milk coolers
(D) Inflammatory response in the udder caused by mastitis

2003
10. Which indicator is most relevant for assessing the general sanitary condition of dairy processing equipment?
(A) Coliform count on equipment surfaces
(B) Total fat residue remaining in pipes
(C) Concentration of casein micelles in rinse water
(D) Freezing point depression of the initial milk flush

2017
11. Which endogenous source is most likely to introduce Staphylococcus aureus directly into raw milk?
(A) Contaminated packaging material
(B) Infected udders of dairy cattle
(C) Aerosols in the dairy plant
(D) Polluted transport vehicle tanks

2021
12. Match the specific milk contaminant in List I with its most common primary source in List II.
List I: (Milk Contaminant)
P. Aflatoxin M_1
Q. Psychrotrophic bacteria
R. Organochlorine residues
S. Antibiotic residues
List II: (Primary Source)
1. Properly sanitized bulk coolers
2. Veterinary treatments for mastitis
3. Ingestion of mold-contaminated feed by cattle
4. Agricultural application of pesticides near grazing areas
(A) P-4, Q-2, R-1, S-3
(B) P-3, Q-1, R-4, S-2
(C) P-3, Q-2, R-4, S-1
(D) P-1, Q-4, R-2, S-3

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2006
13. Which of the following pairs correctly identifies a contamination pathway and its associated hazard in the milk supply chain?
(A) Lubricant leaks from equipment – Chemical hazard
(B) Peeling paint in processing rooms – Biological hazard
(C) Poor industrial ventilation systems – Physical hazard
(D) Active bovine mastitis infections – Chemical hazard

2017
14. If high levels of nitrates and coliforms are simultaneously detected in a farm's raw milk supply, what is the most logical inferred source of this specific dual contamination?
(A) Excessive administration of systemic antibiotics to dairy herds
(B) Direct ingestion of chemical agricultural weedicides by cattle
(C) Contaminated farm water used for washing utensils and udders
(D) Excessive over-chilling of raw milk within bulk storage tanks

2002
15. Based on the classification of contamination sources, which of the following is considered an exogenous chemical contaminant?
(A) Endogenous lactose sugar
(B) Endogenous somatic cells
(C) Endogenous lactoperoxidase
(D) Environmental heavy metals

(B) 1% to 6%
(C) 20% to 30%
(D) 50% to 75%

2015

50. How is Aflatoxin M_1 classified in terms of human health hazards by the International Agency for Research on Cancer (IARC)?
(A) A mild localized gastric irritant with no documented long-term human effects
(B) A highly beneficial dietary prebiotic aiding healthy gut microbiome growth
(C) A highly severe neurotoxic agent causing immediate neuromuscular paralysis
(D) Group 1 carcinogen primarily affecting the liver

2008

51. If a regional dairy cooperative notes a significant spike in Aflatoxin M_1 levels in their bulk milk supply during the late monsoon season, what is the most logical inference?
(A) High humidity caused poor feed storage, promoting Aspergillus growth
(B) Cooperative farmers are deliberately adding excess well water to the milk
(C) The dairy pasteurizer holding temperature has been set too low
(D) Dairy cows are drinking large, excessive amounts of acidic rainwater

2022

52. Which analytical technique is most appropriate and widely used for the highly sensitive, quantitative detection of Aflatoxin M_1 in dairy laboratories?
(A) Gerber fat testing butyrometry
(B) Kjeldahl nitrogen digestion assay
(C) HPLC with fluorescence detection
(D) Standard lactometer gravity reading

2006

53. What does the term "withdrawal period" refer to in the context of antibiotic use in dairy animals?
(A) The required time from last drug dose to safe milk collection for humans
(B) The duration required for a specific antibiotic to cure clinical mastitis
(C) The holding time required for raw milk inside bulk coolers before transit
(D) The total heating duration required to pasteurize and remove drug traces

2001

54. Given below are two statements, one labeled as Assertion (A) and the other as Reason (R).
Assertion (A): The presence of antibiotic residues in milk can cause severe economic losses in the cheese-making industry.
Reason (R): Antibiotics enhance the rapid proliferation of lactic acid starter cultures, causing the cheese curd to acidify too quickly.
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2003

55. Which class of antibiotics is most frequently responsible for residue violations in milk due to their widespread use in treating bovine mastitis?
(A) Macrolide class
(B) Beta-lactams
(C) Aminoglycosides
(D) Fluoroquinolones

2009

56. What is a significant public health effect of chronic exposure to sub-lethal concentrations of antibiotic residues in commercial milk?
(A) Artificially increased calcium absorption and mineral utilization in humans
(B) Direct and complete eradication of all pathogenic human viral infections
(C) Development of resistant bacterial strains and potential allergic reactions
(D) Significantly enhanced preservation and stability of milk in the stomach

2018

57. Which scenario correctly identifies a prophylactic use of antibiotics that may lead to residues, as opposed to a therapeutic use?
(A) Administering intramammary penicillin to a cow showing active mastitis signs
(B) Injecting broad-spectrum therapeutic antibiotics into any severely injured cow
(C) Treating an individual animal diagnosed with acute bacterial bovine pneumonia
(D) Administering dry cow therapy to the herd at lactation's end to prevent infection

2021

58. What is a major advantage of implementing routine rapid antibiotic residue testing at the raw milk reception dock?
(A) It intercepts contaminated tankers to protect starter cultures and health
(B) It allows processing plants to safely dilute

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(A) To organize plant operations and the workforce based on job seniority
(B) To designate specific physical areas for different ice cream flavors
(C) To separate raw and pasteurized product areas to prevent contamination
(D) To map out and analyze the thermal fuel efficiency of heating boilers

2010

25. What is the direct effect of inadequate concentration of nitric acid during the acid wash phase of a dairy CIP system?
(A) Complete enzymatic removal of all sticky organic protein residues
(B) Instantaneous destruction of highly resistant bacterial endospores
(C) Chemical saponification and emulsion of residual raw milk fats
(D) Inability to remove mineral deposits and milk stone

2011

26. Consider the following statements regarding GMP requirements in dairy plants:
I. Windows in processing areas should be devoid of insect screens to allow maximum airflow.
II. Floors must be constructed of impervious, non-absorbent, and easily cleanable materials.
III. Adequate lighting is only required in the final packaging zone, not in raw material handling.
IV. Potable water must be used for all processes involving direct food contact.
Which of the above statement(s) is/are INCORRECT?
(A) I, II and IV
(B) I and III
(C) I, III and IV
(D) II and IV

2012

27. Which statement represents a correct personnel hygiene requirement under standard GMP?
(A) Employees may wear their personal street clothing inside the high-care zone
(B) Employees with communicable diseases or open lesions must be excluded
(C) Handwashing is strictly required only at the start of daily work shifts
(D) Wearing jewelry is allowed if it is covered by standard sanitizing gels

2009

28. Which of the following is NOT covered under the standard prerequisites of Good Hygiene Practices (GHP)?
(A) Solid waste management and liquid effluent disposal procedures
(B) Strategic business pricing of milk
(C) Integrated pest control and prevention programs
(D) Daily equipment cleaning and sanitation schedules

2016

29. If a dairy plant suddenly experiences repetitive occurrences of insect fragments in packaged cheese, which GHP component can be inferred to have critically failed?
(A) Integrated pest management
(B) Standard equipment calibration procedures
(C) Employee financial incentive and compensation plans
(D) Cold chain logistics and transport temperature logging

2018

30. What is a key advantage of implementing standardized Good Manufacturing Practices (GMP)?
(A) It completely eliminates the technical requirement for any subsequent HACCP systems
(B) It replaces the need for skilled and trained personnel on the floor
(C) It standardizes quality and minimizes contamination risks
(D) It legally permits processing of slightly acidic or spoiled incoming raw milk

2012

31. Which action is most appropriate to verify that CIP procedures are effective under standard GMPs?
(A) Visually inspecting the exterior structural parts of the large milk silos only
(B) Informally asking the cleaning operator if the automated cycle sounded normal
(C) Tasting the flavor of the very first batch of milk processed after cleaning
(D) Reviewing chemical concentration logs and conducting regular ATP swab tests

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2002

32. How are Good Laboratory Practices (GLP) best defined in the context of dairy quality control?
(A) The physical layout and engineering design of heavy laboratory benches and chemical

fume hoods
(B) The specific volumetric chemical reactions routinely used to determine raw milk fat content
(C) A quality system for planning, performing, monitoring, and reporting lab studies
(D) Strategic industry guidelines for marketing newly designed dairy analytical equipment

2025
33. Consider the following statements regarding GLP principles in dairy laboratories:
I. Standard Operating Procedures (SOPs) must be documented and accessible for all analytical methods.
II. Reagents and solutions must be appropriately labeled with concentration and expiry dates.
III. Raw analytical data can be discarded once the final report is generated.
IV. Analytical instruments must undergo routine calibration against certified reference materials.
V. Personnel conducting specific analyses do not require documented training records.
Which of the above statement(s) is/are correct?
(A) I, II, III and V
(B) I, II and IV
(C) I, III and IV
(D) I, II, IV and V

2014
34. Which of the following practices does NOT comply with the guidelines for reagent handling in a GLP-compliant dairy laboratory?
(A) Storing light-sensitive reagents in amber glass bottles
(B) Documenting the preparation date and preparer's initials on working solutions
(C) Segregating volatile solvents from strong oxidizers
(D) Pouring excess chemical reagents back into their original stock containers

2006
35. Under GLP, what is the mandatory requirement for analytical balances used to weigh milk samples?
(A) They must be calibrated daily using traceable weights
(B) They must be painted white to reflect high cleanliness standards
(C) They should be placed right next to high-speed centrifuges to save workspace
(D) They require calibration only when relocated to a new laboratory facility

2021
36. What is the immediate effect of using contaminated blank samples during the spectrophotometric analysis of milk for contaminants?
(A) It corrects instrument baseline errors automatically
(B) It increases physical yields of extracted compounds
(C) It causes falsely depressed concentration readings
(D) It prevents physical degradation of internal lamps

2013
37. Which of the following correctly pairs a GLP function with its required laboratory equipment?
(A) Aseptic inoculation – Laminar air flow cabinet
(B) Precise volume measurement – Uncalibrated beaker
(C) Incubation of coliform plates – High-heat furnace
(D) Storage of reference cultures – Standard hot air oven

2015
38. The internationally recognized principles of GLP, often applied to safety testing of food and dairy additives, were originally formalized by which organization?
(A) World Trade Organization (WTO)
(B) International Dairy Federation (IDF)
(C) International Monetary Fund (IMF)
(D) Organization for Economic Co-operation and Development (OECD)

2021
39. In a GLP framework, why is "sample traceability" a critical concept during dairy quality analysis?
(A) It ensures that the measured physical sample weight increases linearly over time
(B) It tracks the sample back to its original supplier, batch, and collection time
(C) It permits the mixing of distinct product batches to optimize chemical reagents
(D) It directly establishes the market retail price of the tested dairy product

2015
40. Select the correct standard sequence for handling a raw milk sample for microbial analysis under GLP guidelines.
(A) Incubation, sampling, plating, transportation
(B) Sampling, transportation under cold chain, aseptic plating, incubation, reporting
(C) Plating, reporting, sampling, cold storage

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(D) Transportation, incubation, sampling, aseptic plating

2014

41. What is the primary advantage of strict documentation and archiving as mandated by GLP?
(A) It minimizes the overall storage space required within laboratories
(B) It removes the requirement for using personal protective equipment
(C) It accelerates chemical reaction and processing times of all assays
(D) It allows analytical data to be reconstructed and audited

2022

42. What exactly is Aflatoxin M_1 in the context of dairy science?
(A) The metabolic byproduct of Aflatoxin B_1 excreted in milk
(B) A chemical synthetic preservative directly added to raw milk
(C) A naturally occurring bioactive protein found in sweet whey
(D) A toxic heavy metal complex formed during pasteurization processes

2025

43. Which environmental organism is the primary producer of the precursor toxin (Aflatoxin B_1) that ultimately leads to Aflatoxin M_1 in milk?
(A) Pseudomonas fluorescens
(B) Aspergillus flavus
(C) Penicillium roqueforti
(D) Bacillus cereus

2017

44. According to the Food Safety and Standards Authority of India (FSSAI) regulations, what is the maximum permissible limit of Aflatoxin M_1 in liquid milk?
(A) 0.5 µg/kg (ppb)
(B) 1.0 µg/kg (ppb)
(C) 5.0 µg/kg (ppb)
(D) 10.0 µg/kg (ppb)

2018

45. Which of the following statements about the physicochemical properties of Aflatoxin M_1 in milk is correct?
(A) It is heat-stable and survives normal pasteurization and UHT
(B) It is highly volatile and completely evaporates upon exposure to air
(C) It undergoes rapid structural degradation when milk is chilled to 4°C
(D) It is easily neutralized by adding normal amounts of sodium chloride

2016

46. What is the direct effect on a dairy cow if its feed is heavily contaminated with mold producing Aflatoxin B_1?
(A) The cow will excrete pure Aflatoxin B_1 into milk without any metabolic change
(B) The cow's raw milk will undergo immediate physical curdling inside the udder
(C) The liver metabolizes it, excreting Aflatoxin M_1 in milk within 12–24 hours
(D) The animal will produce raw milk containing double the standard fat content

2021

47. Arrange the correct chronological order of the pathway leading to Aflatoxin M_1 contamination in the milk supply chain.
I. Cow ingests contaminated feed.
II. Mold grows on improperly stored animal feed.
III. Aflatoxin M_1 is secreted into the mammary gland.
IV. Aflatoxin B_1 is produced in the feed.
V. Aflatoxin B_1 is metabolized in the cow's liver to M_1.
Which of the following represents the correct sequence?
(A) II, IV, I, V, III
(B) I, II, IV, III, V
(C) IV, II, I, V, III
(D) II, I, IV, V, III

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2006

48. Which of the following statements is correct regarding the effect of dairy processing on Aflatoxin M_1?
(A) Standard pasteurization completely destroys Aflatoxin M_1.
(B) Spray drying into milk powder reduces Aflatoxin M_1 concentration by 95%.
(C) Standard processing methods like pasteurization and boiling are ineffective at destroying Aflatoxin M_1.
(D) Boiling milk for 5 minutes completely inactivates Aflatoxin M_1.

2009

49. The carry-over rate (excretion rate) of Aflatoxin B_1 from feed to Aflatoxin M_1 in milk is typically estimated to be in what percentage range?
(A) 0.1% to 0.2%

2006

16. In comparing contamination sources, how does human handling primarily differ from equipment biofilm in terms of the pathogenic profile introduced to milk?
(A) Human handling is far more likely to introduce highly heat-resistant thermophilic spores than machinery biofilms
(B) Human handling directly introduces toxic heavy metals, whereas machinery biofilms introduce agricultural pesticide residues
(C) Human handling introduces Salmonella/ Shigella, while biofilms harbor Listeria/ Pseudomonas
(D) Human handling is classified strictly as a physical hazard, whereas machinery biofilms are chemical hazards

2003

17. Which physical hazard is most commonly associated with poorly maintained glass thermometers in milk silos?
(A) Introduction of toxic heavy metals
(B) Glass shard contamination
(C) Microplastics infiltration
(D) Rust particulate suspension

2019

18. Which preventive action is most appropriate to mitigate the risk of toxic veterinary drug residues entering the milk supply?
(A) Boiling all incoming raw milk immediately upon reaching the processing plant
(B) Increasing the thermal pasteurization holding time by at least ten seconds
(C) Filtering bulk raw milk through specialized active carbon filter meshes
(D) Adhering strictly to mandatory drug withdrawal periods

2021

19. Consider the following statements regarding sources of contamination in milk:
I. Extraneous water addition often introduces psychrotrophic pathogens.
II. Milk stone buildup on equipment acts as a reservoir for thermoduric bacteria.
III. Feed containing excessive urea has no impact on milk composition.
Which of the above statement(s) is/are correct?
(A) I
(B) II and III
(C) I and II
(D) I and III

2016

20. Which of the following practices effectively eliminates the risk of heavy metal contamination via dairy plant processing equipment?
(A) Coating inner milk pipe surfaces with industrial lead-based sealants
(B) Utilizing copper-based vats for long-term storage of acidic whey
(C) Using 304 or 316 stainless steel on food-contact surfaces
(D) Rinsing all processing pipelines with highly concentrated chlorine

2024

21. How is Good Hygiene Practice (GHP) fundamentally defined in the context of dairy operations?
(A) Prerequisite basic hygienic conditions and practices for food safety
(B) A detailed financial auditing mechanism for calculating processing costs
(C) Relying exclusively on end-product testing to verify microbial safety
(D) A regulatory framework designed for controlling pesticide use on farms

2014

22. Good Manufacturing Practices (GMP) in a dairy plant primarily encompass which of the following elements?
(A) Farm-level genetic selection and selective herd breeding improvements
(B) Commercial marketing and long-distance distribution strategies for products
(C) Setting legal Maximum Residue Limits (MRLs) for synthetic food additives
(D) Design and maintenance of premises, equipment, and process controls

2006

23. In applying sanitation principles within a dairy plant, what is the correct sequence of operations in a standard Clean-In-Place (CIP) cycle?
(A) Acid wash, water rinse, alkali wash, final water rinse
(B) Pre-rinse, alkali wash, intermediate rinse, acid wash, final rinse, sanitization
(C) Sanitization, alkali wash, acid wash, pre-rinse
(D) Pre-rinse, sanitization, intermediate rinse, hot air drying

2014

24. What is the primary purpose of establishing "zoning" (e.g., red, yellow, green zones) in a dairy processing facility?

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contaminated milk with clean milk
(C) It physically extracts and removes antibiotic residues from the milk during tests
(D) It directly increases the nutritional value and total solids content of milk

2018
59. Which of the following is an INCORRECT statement regarding the stability of antibiotic residues in milk?
(A) Beta-lactam residues are not fully destroyed by pasteurization
(B) Boiling milk completely eliminates tetracycline and sulfonamide residues
(C) Routine cold storage at 4°C does not degrade residues in raw milk
(D) Drying milk into powder concentrates the residues from liquid milk

2021
60. A yogurt manufacturer notes that a specific batch of milk fails to coagulate and the pH does not drop after standard incubation with Streptococcus thermophilus and Lactobacillus delbrueckii subsp. bulgaricus. Applying dairy microbiology concepts, what is the most likely cause?
(A) The raw milk was heavily over-pasteurized
(B) The milk contains antibiotic residues
(C) The milk had an extremely high fat content
(D) The incubation temperature was held at 42°C

2006
61. Match the antibiotic class or term in List I with its associated characteristic in List II.
List I: (Antibiotic Class/Term)
P. Penicillin G
Q. Tetracyclines
R. Withdrawal period
S. Chloramphenicol
List II: (Associated Characteristic)
1. Broad-spectrum antibiotics often binding to calcium
2. Banned for use in food-producing animals in many countries due to aplastic anemia risk
3. Common beta-lactam causing allergic reactions in sensitive individuals
4. Time required for drug clearance from the animal's body
(A) P-3, Q-1, R-4, S-2
(B) P-1, Q-3, R-2, S-4
(C) P-3, Q-4, R-1, S-2
(D) P-2, Q-1, R-4, S-3

2004
62. Which of the following approaches is generally eliminated as a viable method for managing milk heavily contaminated with antibiotic residues?
(A) Discarding and destroying the contaminated milk safely
(B) Using the milk exclusively to feed young calves on the farm
(C) Processing contaminated milk into UHT milk to bypass rules
(D) Tracing contamination back to the farmer for corrective action

2016
63. The standard Delvotest SP-NT, used globally for detecting antibiotic residues in milk, relies on the growth inhibition of which specific test organism?
(A) Escherichia coli
(B) Lactobacillus rhamnosus
(C) Staphylococcus aureus
(D) Bacillus stearothermophilus var. calidolactis

2004
64. What is the fundamental principle behind the Charm ROSA (Rapid One Step Assay) test used in dairy reception?
(A) Gas chromatography mass spectrometry
(B) Chemical titrimetric neutralization
(C) Lateral flow receptor assay
(D) Microbial acid fermentation color changes

2012
65. In comparing the Delvotest (microbial inhibition) with the Charm lateral flow test, which statement is accurate?
(A) The Delvotest yields results in five minutes, but the Charm test needs three hours
(B) The Charm test targets specific drug families, while Delvotest is broad-spectrum
(C) The Delvotest system requires mass spectrometers, while the Charm test needs incubators
(D) The Charm test is cheaper and demands far more technical expertise than Delvotest

2001
66. Which pair correctly matches the detection method with its output signal?
(A) Charm ROSA test – Visual measurement of bacterial gas production
(B) HPLC – Electronic colony counting on standard nutrient agar plates
(C) MBRT – Automatic scanning of standard electronic barcodes
(D) Delvotest – Color change from purple to

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cattle are treated with anti-parasitic dermal pour-ons.

V. Boiling milk for 2 hours to easily evaporate all heavy pesticide molecules.

Which of the above statement(s) is/are correct?

(A) I, II and IV
(B) I, III, IV and V
(C) II, IV and V
(D) I, II and III

2010

83. Which of the following processes is INCORRECTLY suggested as a method to reduce pesticide residues in milk, because the residues are highly heat-stable?

(A) Thermal pasteurization
(B) Blending with residue-free milk
(C) Centrifugal skimming to remove fat
(D) Diversion of contaminated milk from the food chain

2004

84. What is a primary environmental source that introduces lead (Pb) contamination into the dairy food chain?

(A) Natural volcanic activity emitting lead vapor directly into farm milk silos
(B) The intentional addition of lead compounds to cattle feed to improve bone density
(C) Industrial emissions, vehicle exhaust, and soil ingestion by cattle
(D) Slow structural degradation and wear of modern food-grade stainless steel milk pipes

2009

85. Chronic ingestion of cadmium (Cd) through contaminated food chains, including milk, is strongly associated with toxicity affecting which major human organ system?

(A) The kidneys and the skeletal system
(B) The cardiovascular system of humans
(C) The human integumentary system
(D) The human ocular sensory system

2008

86. Which of the following is an INCORRECT statement regarding mercury (Hg) contamination in milk?

(A) Mercury can enter the food chain through industrial effluents polluting water sources
(B) Inorganic mercury can be biologically methylated in the environment into highly toxic methylmercury
(C) Mercury is a potent neurotoxin affecting human health
(D) Mercury levels in cow's milk are naturally very high, typically exceeding 500 mg/kg

2009

87. How does arsenic predominantly enter a dairy cow's system in endemic regions (such as parts of West Bengal and Bangladesh)?

(A) Through the routine daily use of chemical arsenic-based antibacterial teat dips
(B) Through drinking water and fodder crops drawn from contaminated groundwater
(C) Through aerosolized airborne arsenic particles during long-distance transport
(D) Through the dairy cow's natural metabolic pathways synthesizing heavy arsenic

2015

88. In comparing the toxicity of heavy metal forms, how does methylmercury differ from elemental mercury?

(A) Elemental mercury is readily absorbed in the gut, whereas methylmercury is not
(B) Methylmercury is safely metabolized by liver cells into essential amino acids
(C) Methylmercury is highly bioavailable, bioaccumulative, and highly neurotoxic
(D) There is no toxicological difference; both forms have identical risk profiles

2004

89. Which of the following represents the correct sequence of steps for the standard laboratory analysis of heavy metals in milk using Atomic Absorption Spectroscopy (AAS)?

(A) Sample digestion (wet or dry ashing) → Aspiration into flame/furnace → Absorption measurement → Dilution
(B) Dilution → Absorption measurement → Sample digestion → Aspiration
(C) Sample collection → Sample digestion (ashing to destroy organic matter) → Reconstitution/Dilution → Aspiration and Absorption measurement
(D) Aspiration → Reconstitution → Digestion → Absorption measurement

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2018

90. Which historical processing practice was a significant direct cause of lead and copper contamination in dairy products before the universal adoption of stainless steel?

(A) Storing milk in poorly tinned copper or brass vessels with lead solder
(B) Using modern food-grade plastic piping systems throughout the entire dairy plant

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(D) The exact minimum lethal dose of a pesticide for a human being

2015

75. Consider the following statements regarding organochlorine pesticides (e.g., DDT, Lindane) in the dairy context:

I. They are highly lipophilic, meaning they concentrate heavily in the milk fat.
II. They break down rapidly in the environment, posing a very short-term risk.
III. They bioaccumulate in the food chain, ultimately reaching high concentrations in bovine milk.
IV. Many have been banned globally due to their persistence and toxicity.

Which of the above statement(s) is/are correct?
(A) I, II and IV
(B) I, III and IV
(C) II, III and IV
(D) I and III

2003

76. When dairy cattle graze on pastures heavily treated with DDT decades ago, why might DDT metabolites (like DDE) still appear in their milk today?
(A) Because DDT compounds are naturally synthesized by common pasture grass species
(B) Because organochlorines persist in soil and resist degradation
(C) Because commercial modern fertilizers frequently contain hidden active DDT elements
(D) Because dairy cows genetically inherit pesticide molecules from their ancestors

2023

77. Which statement accurately describes organophosphate pesticides compared to organochlorines in relation to milk contamination?
(A) They are less persistent and are excreted rapidly, reducing chronic milk contamination
(B) Organophosphates remain vastly more persistent in the soil environment than organochlorines
(C) Organophosphates concentrate exclusively within the functional sweet whey protein fraction
(D) Organophosphates are chemical compounds that are entirely non-toxic to normal humans

2017

78. To which broad chemical classification do pesticides such as chlorpyrifos, malathion, and parathion belong?
(A) Synthetic pyrethroids
(B) Organochlorines
(C) Organophosphates
(D) Carbamates

2012

79. Which specific phenomenon causes the concentration of lipophilic pesticides to increase at successive trophic levels, culminating in high levels in dairy milk?
(A) Eutrophication
(B) Pasteurization
(C) Homogenization
(D) Biomagnification

2006

80. What is the direct effect of the highly lipophilic nature of organochlorine residues when whole milk is processed into butter?
(A) The residues are entirely lost in the liquid buttermilk fraction during churning
(B) The residues evaporate completely into the surrounding air during the churning process
(C) The residues concentrate heavily in the butter phase
(D) The residues bind exclusively to casein micelles, leaving finished butter residue-free

2007

81. Which statement identifies the correct primary entry pathway for weedicides (herbicides) into the dairy supply chain?
(A) Direct therapeutic injection of herbicides into the bovine udder to treat mastitis
(B) Ingestion of contaminated fodder or water runoff by cattle
(C) Airborne transmission from spraying aircraft directly into standard milking parlors
(D) Intentional use of active weedicides as sanitizers for stainless milking equipment

2024

82. Consider the following statements regarding mitigation strategies for pesticide residues in milk:

I. Ensuring cattle feed is sourced from certified organic or pesticide-controlled farms.
II. Routine monitoring of raw milk using Gas Chromatography (GC).
III. Washing the cows with organophosphate dips immediately before milking.
IV. Implementing strict withholding periods if

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yellow when negative

2009

67. What is the standard incubation time and temperature typically required for a microbial inhibition test like the Delvotest to yield a result?
(A) 10 minutes at room temperature
(B) 2.5 to 3 hours at 64°C
(C) 24 hours at 37°C
(D) 48 hours at 4°C

2024

68. Consider the following statements regarding the limitations of rapid detection methods for antibiotics:
I. They can occasionally yield false positives due to high somatic cell counts or naturally occurring inhibitors.
II. They provide exact quantification (down to the exact ppb) of multiple different antibiotics simultaneously.
III. They may fail to detect certain drug classes if the specific receptor or antibody is absent in the test strip.
Which of the above statement(s) is/are INCORRECT?
(A) I and III
(B) II
(C) I
(D) II and III

2015

69. Which type of assay specifically utilizes radiolabeled or enzyme-labeled antibiotics competing with residues in the milk for binding sites on added bacterial cells or antibiotics?
(A) Competitive immunoassay
(B) Standard plate count method
(C) Freezing point osmometry test
(D) Gerber butyrometry method

2016

70. What is a common cause of a "false positive" result in a microbial inhibition assay like the Delvotest?
(A) The raw milk contains extremely high levels of intentionally added water
(B) The raw milk sample has been excessively homogenized at high pressures
(C) The test incubator temperature is held perfectly at sixty-four degrees
(D) The milk contains high levels of natural antimicrobials from colostrum

2006

71. If a lateral flow strip designed to detect beta-lactams at 4 ppb shows a positive line for a sample, but HPLC analysis reveals the actual concentration is 2 ppb, what can be inferred about the rapid test?
(A) The lateral flow rapid test is completely defective and useless
(B) The test has a lower sensitivity threshold or cross-reacted
(C) The rapid test device specifically generated a false negative
(D) The HPLC analytical method is far less sensitive than human vision

2019

72. Which of the following analytical instruments is NOT typically used for the routine or confirmatory detection of antibiotic residues in milk?
(A) Liquid Chromatography-Tandem Mass Spectrometry (LC-MS/MS)
(B) High-Performance Liquid Chromatography (HPLC)
(C) MilkoTester (infrared milk analyzer for fat/protein)
(D) Enzyme-Linked Immunosorbent Assay (ELISA) reader

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2016

73. Which detection strategy is most appropriate for a large-scale dairy reception dock handling hundreds of tanker trucks daily?
(A) Running expensive, highly complex confirmatory LC-MS/MS on every single tanker before unloading
(B) Using a standard broad-spectrum microbial inhibition test that takes three hours per tanker
(C) Skipping all antibiotic residue testing programs to avoid delaying the daily unloading
(D) Using rapid lateral flow tests for screening, then saving positives for confirmation

2011

74. How is the Maximum Residue Limit (MRL) defined in the context of pesticide residues in dairy products?
(A) The maximum pesticide concentration legally permitted in food
(B) The absolute lowest concentration detectable by modern lab equipment
(C) The chemical pesticide amount added to milk to act as preservative

(C) Using heavy-duty commercial titanium-based plates within heat exchangers
(D) Pumping hot liquid milk through long high-durability laboratory glass pipelines

2023
91. If high levels of both cadmium and lead are detected in the milk from a specific dairy farm, what is the most scientifically sound inference regarding the source?
(A) The dairy cows are actively experiencing a severe systemic acute viral herd infection
(B) The farm is located near smelting plants, busy highways, or uses sewage fertilizer
(C) The automated milking machines are operating at extremely high internal vacuum pressures
(D) The farm is feeding its milking herd purely organic and specialized hydroponic grass

2003
92. Which of the following elements is NOT classified as a toxic heavy metal contaminant, but is rather an essential micronutrient for humans and cattle at normal physiological levels?
(A) Lead (Pb)
(B) Zinc (Zn)
(C) Arsenic (As)
(D) Cadmium (Cd)

2003
93. What is the cause-and-effect relationship regarding heavy metals and bio-magnification?
(A) Resisting metabolic breakdown, their concentration increases at higher trophic levels
(B) Heavy metals break down rapidly in environmental water, causing zero accumulation in cattle
(C) Heavy metals evaporate from hot soil, causing cattle to inhale them, lowering tissues
(D) Agricultural plants selectively destroy heavy metals, protecting the herbivores that eat them

2010
94. Which of the following analytical techniques is most appropriate and modern for the simultaneous, multi-element trace detection of heavy metals (like Pb, Cd, As) in milk at parts-per-billion levels?
(A) Gerber method
(B) Soxhlet method
(C) ICP-MS
(D) Flame method

2022
95. What was the primary legislative purpose of enacting the Food Safety and Standards (FSS) Act, 2006 in India?
(A) To purely promote and financially subsidize the export of all Indian dairy products
(B) To legally mandate that all domestic dairy farming operations must be state-owned
(C) To strictly regulate the market pricing and taxation of agricultural food commodities
(D) To consolidate older food laws and establish FSSAI for science-based standards

2014
96. Arrange the logical sequence for a dairy processing unit applying for a new FSSAI Central License.
I. FSSAI authority inspects the premises.
II. Applicant submits Form-B via the FoSCoS portal with required documents.
III. FSSAI issues the 14-digit License Number.
IV. Application is scrutinized for completeness by the Designated Officer.
Which of the following represents the correct sequence?
(A) II, IV, I, III
(B) II, I, IV, III
(C) IV, II, I, III
(D) I, II, IV, III

2013
97. The Food Safety and Standards Authority of India (FSSAI) operates under the administrative control of which Union Ministry?
(A) Ministry of Agriculture and Farmers Welfare
(B) Ministry of Health and Family Welfare
(C) Ministry of Fisheries, Animal Husbandry and Dairying
(D) Ministry of Commerce and Industry

2002
98. In the context of FSSAI regulations, what critical food safety aspect is detailed in "Schedule 4" of the Licensing and Registration regulations?
(A) The exact maximum retail market price and taxation of commercial dairy products
(B) The detailed nutritional labeling guidelines for all types of exported foods
(C) The specific chemical structural formulas for modern synthetic artificial sweeteners
(D) General hygienic and sanitary practices for food business operators (GMP/GHP)

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solids content
(D) Freezing point osmometry – Enumeration of bacterial count

2012

131. Consider the following precautions required during the sampling of milk according to BIS guidelines:
I. The milk must be thoroughly plunged and mixed before sampling.
II. The sample container must be clean, dry, and sterile if meant for bacteriological testing.
III. Preservatives like potassium dichromate should be added to samples meant for immediate organoleptic evaluation.
IV. Samples should be kept exposed to direct sunlight to ensure warmth.
V. The sampling dipper must be sanitized between different batches.
Which of the above statements are INCORRECT?
(A) I, II and V
(B) III and IV
(C) I, III and V
(D) II, IV and V

2007

132. In the Gerber method (IS 1224), what is the specific volumetric capacity calibration of the standard milk pipette used to deliver the milk into the butyrometer?
(A) 1.00 ml
(B) 10.00 ml
(C) 10.75 ml
(D) 11.00 ml

2007

133. What is the immediate cause-and-effect consequence of failing to thoroughly mix a large bulk milk cooling tank before taking a sample for fat analysis?
(A) The total solids and density measurements will shift proportionally, reading higher than the fat content
(B) Stratification of fat (creaming) occurs, causing inaccurate, non-representative fat readings
(C) The milk will undergo rapid enzymatic degradation and instantly sour during the testing process
(D) The laboratory pipette will experience thermal shock and shatter upon contact with the cold milk

2013

134. Which of the following pairs of chemical reagents is used in the standard Gerber method (IS 1224) for the determination of fat in milk?
(A) Sulfuric acid and amyl alcohol
(B) Hydrochloric acid and ethyl ether
(C) Sodium hydroxide and petroleum ether
(D) Nitric acid and chloroform

2008

135. Comparing fat determination methods, how does the Roese-Gottlieb method primarily differ from the Gerber method?
(A) Roese-Gottlieb operates as a rapid volumetric field test for raw milk, whereas Gerber serves as a gravimetric reference standard
(B) Roese-Gottlieb measures total protein and nitrogenous content, whereas Gerber is designed to measure lipid and lipid-soluble fractions
(C) Roese-Gottlieb requires microbial fermentation by specific bacterial cultures, whereas Gerber relies entirely on chemical digestion
(D) Roese-Gottlieb is a gravimetric reference method using solvent extraction, while Gerber is a volumetric screening method

2005

136. What is the key analytical advantage of using the gravimetric method (drying in an oven) for total solids determination over using a simple lactometer reading?
(A) Gravimetry physically measures dry matter directly, avoiding errors from specific gravity or temperature
(B) Gravimetry performs rapid scanning in under two minutes without requiring sample pre-treatment
(C) Gravimetry requires basic household utensils and absolutely no calibrated laboratory equipment
(D) Gravimetry simultaneously identifies and enumerates the specific pathogenic bacteria in the milk

2018

137. The AGMARK certification is legally governed under which specific Indian legislation?
(A) The Agricultural Produce (Grading and Marking) Act, 1937
(B) The Prevention of Food Adulteration Act, 1954
(C) The Essential Commodities Act, 1955
(D) The Bureau of Indian Standards Act, 1986

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(C) Fat 4.5%, SNF 8.5%
(D) Fat 6.0%, SNF 9.0%

2003

107. As per FSSAI standard definitions, what is the minimum Milk Fat requirement for "Standardized Milk"?
(A) 1.5%
(B) 3.0%
(C) 4.5%
(D) 6.0%

2023

108. Which statement is correct regarding the use of additives in plain, pasteurized liquid milk as per FSSAI regulations?
(A) Synthetic chemical colors are permitted to enhance the natural whiteness of buffalo milk
(B) Adding any food additive, preservative, or color is strictly prohibited
(C) Formalin is a legally permitted preservation agent up to concentrations of 0.1%
(D) Pure starch can be routinely added to artificially improve the viscosity of toned milk

2025

109. If a dairy plant receives buffalo milk with 7% fat and 9% SNF and processes it by adding strictly separated skim milk to bring the final composition to 1.5% fat and 9.0% SNF, the plant is producing:
(A) Double Toned Milk
(B) Full Cream Milk
(C) Standardized Milk
(D) Toned Milk

2014

110. Match the liquid milk variant in List I with its all-India FSSAI minimum standard (Fat% / SNF%) in List II.
List I: (Liquid Milk Variant)
P. Full Cream Milk
Q. Double Toned Milk
R. Skimmed Milk
S. Cow Milk (Chandigarh region standard as example)
List II: (Minimum Standard)
1. Fat max 0.5% / SNF min 8.7%
2. Fat min 6.0% / SNF min 9.0%
3. Fat min 4.0% / SNF min 8.5%
4. Fat min 1.5% / SNF min 9.0%
(A) P-3, Q-1, R-4, S-2
(B) P-2, Q-1, R-4, S-3
(C) P-2, Q-4, R-1, S-3
(D) P-4, Q-2, R-1, S-3

2011

111. Under FSSAI classifications, how does Hydrogen Peroxide (H_2O_2) strictly differ from Nisin in dairy applications?
(A) Both substances are universally classified and legally permitted as natural organic food colors
(B) H_2O_2 is used as a natural flavoring compound, while Nisin is classified as a toxic heavy metal
(C) Both compounds are universally and strictly banned in all types of commercial dairy processing
(D) Nisin is a permitted bio-preservative, while raw milk addition of H_2O_2 is adulteration

2023

112. Applying FSSAI definitions, what constitutes "Recombined Milk"?
(A) Commercial liquid milk resulting from the direct addition of tap water to skimmed milk powder only
(B) Simply mixing raw cow milk and raw buffalo milk together in equal proportions at farm level
(C) Product made by mixing butter oil, skim milk powder, and water to meet fat/SNF standards
(D) Raw whole milk that has been boiled twice successively to extend its daily shelf life

2002

113. Which of the following pairs regarding permissible additives in specific dairy products is INCORRECTLY matched according to general FSSAI guidelines?
(A) Flavored Milk – Permitted artificial food colors
(B) Plain pasteurized whole milk – Natamycin preservative
(C) Processed Cheese – Emulsifying salts (e.g., sodium citrates)
(D) Ghee – Synthetic antioxidants like BHA (up to permitted limits)

2014

114. Which of the following is the most appropriate permitted additive to prevent oxidative rancidity in commercial dairy products like milk powder or butter (where legally allowed)?
(A) Formaldehyde chemical
(B) Melamine compounds

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(C) Synthetic urea additive
(D) BHA or Tocopherols

2003
115. Which process is NOT considered an "adulteration" practice because it is entirely legal and standard in dairy processing under FSSAI?
(A) Extraction of fat to produce skim milk
(B) Addition of neutralizers (like sodium bicarbonate) to sour milk
(C) Addition of starch to increase SNF
(D) Addition of tap water to increase volume

2006
116. The Bureau of Indian Standards (BIS) was established under the BIS Act. Which year marked the enactment of the original modern BIS Act (replacing the ISI Certification Marks Act)?
(A) 1947
(B) 1986
(C) 2006
(D) 2011

2022
117. Consider the following dairy products:
I. Condensed Milk (Sweetened and Unsweetened)
II. Milk Powder (Whole and Skimmed)
III. Pasteurized Liquid Milk in pouches
Which of the above products currently fall under the mandatory ISI Certification marks scheme (required before sale in India)?
(A) I only
(B) II and III only
(C) I and II only
(D) I, II, and III

2001
118. The ISI mark specifically certifies that a dairy product conforms to what criteria?
(A) The standard retail pricing and distribution guidelines set by the government
(B) Only the international CODEX standards, completely ignoring domestic rules
(C) The relevant Indian Standard (IS) specifications for quality and safety
(D) The aesthetic design and labeling details of the final packaging material

2018
119. Conceptually, how does BIS certification primarily differ from basic FSSAI licensing for most dairy products?
(A) FSSAI establishes voluntary regional distribution guidelines, whereas BIS mandates all domestic food production licenses
(B) BIS manages international export clearance certificates, whereas FSSAI oversees general agricultural import permits
(C) BIS registers processing machinery safety, whereas FSSAI regulates agricultural cultivation and livestock farming
(D) FSSAI enforces baseline food safety compliance, whereas BIS certifies adherence to elevated quality standards

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2024
120. Which of the following is an INCORRECT statement regarding the Bureau of Indian Standards (BIS) licensing process?
(A) The ISI mark can be self-applied by any dairy manufacturer without formal BIS approval
(B) A manufacturer must have an in-house laboratory equipped to test the product as per the relevant IS standard
(C) BIS officials conduct periodic surveillance audits and draw samples from the open market
(D) The license is granted initially for a specific period (e.g., one or two years) and requires renewal

2012
121. What is the specific Indian Standard (IS) number associated with the specification for Pasteurized Milk?
(A) IS 1166
(B) IS 1224
(C) IS 2802
(D) IS 13688

2006
122. What is the cause-and-effect regulatory action if a batch of milk powder carrying the ISI mark fails to meet the compositional parameters during a BIS surveillance check?
(A) The manufacturer is awarded a quality subsidy
(B) The BIS license may be suspended or cancelled, and product recall initiated
(C) The FSSAI immediately shuts down the entire BIS organization
(D) The standard parameters are automatically lowered to accommodate the batch

2023

123. In comparing FSSAI and BIS standards for a specific dairy product like Milk Powder, which scenario applies if their specified limits slightly differ?

(A) The product must satisfy both the legal FSSAI requirements and the BIS standard specifications

(B) The manufacturing facility is legally permitted to bypass both regulations under special trade zones

(C) The voluntary BIS standards completely override and nullify national FSSAI food safety laws in court

(D) The FSSAI safety regulations apply exclusively to raw, unprocessed milk rather than finished powders

2014

124. Consider the following requirements for a dairy plant seeking to maintain a BIS license:

I. Continuous compliance with the Scheme of Testing and Inspection (STI).

II. Maintenance of calibration records for all laboratory equipment.

III. Ensuring all packaging material displays the ISI mark accurately along with the CM/L number.

IV. Mandatory replacement of all human workers with automated robotics.

Which of the above statements are correct?

(A) I, II and III

(B) I and II

(C) II, III and IV

(D) I, III and IV

2018

125. Which function is the most appropriate role of the BIS surveillance audits in the dairy industry?

(A) To regulate and enforce the final retail pricing structure of dairy products in local markets

(B) To create and trademark the promotional marketing logos and brand designs for dairy cooperatives

(C) To conduct educational training programs for farm livestock to increase daily raw milk yield

(D) To monitor continuous compliance with quality standards after the initial license is issued

2011

126. How does BIS (IS 11546) define a "representative sample" of milk?

(A) A random, quick portion scooped directly from the surface of an unagitated storage tank

(B) A sample drawn exclusively from the bottom drainage valve without any prior agitation or stirring

(C) A portion representing the exact chemical and physical composition of the entire bulk volume

(D) A portion of raw milk that has been thoroughly boiled and filtered to remove particulate matter

2024

127. According to IS 1224 (Part 1), which standard method is used for the determination of fat in whole milk, evaporated milk, and separated milk?

(A) Soxhlet extraction method

(B) Gerber method

(C) Kjeldahl method

(D) Roese-Gottlieb method

2006

128. What does the standard IS 1479 predominantly cover in the context of Indian dairy science?

(A) Layout and construction specifications for building modern dairy processing facilities

(B) Guidelines for livestock selection, breeding, and herd health management on dairy farms

(C) Financial pricing structures and regulatory models for raw milk procurement from farmers

(D) Standardized methods of rapid, chemical, and bacteriological testing for dairy products

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2003

129. If a dairy laboratory needs to analyze the average fat content of milk supplied over an entire week by preserving daily samples, which valid sampling concept are they utilizing?

(A) Composite sampling

(B) Aseptic sampling

(C) Grab sampling

(D) Destructive sampling

2021

130. Which of the following correctly pairs the BIS standard analytical method with the parameter it measures in milk?

(A) Kjeldahl method – Estimation of total fat in milk

(B) Gerber method – Quantitative analysis of total protein

(C) Gravimetric drying in hot air oven – Total

2009

99. Which of the following statements correctly describes the mandatory display requirement under the Food Safety and Standards (Licensing and Registration of Food Businesses) Regulations for a licensed dairy Food Business Operator (FBO)?

(A) The FSSAI License Number must be displayed prominently at the business premises and printed on all applicable food packages

(B) The FSSAI License Number is required only for export consignments and need not appear on products sold within India

(C) The FSSAI License Number is displayed only during official inspections and is otherwise kept confidential

(D) Only the manufacturing date and batch number are legally required to be displayed, while the FSSAI License Number is optional

2005

100. A large multi-state dairy cooperative operates processing plants in Gujarat, Maharashtra, and Delhi, each handling over 1,00,000 liters of milk per day. According to FSSAI regulations, what type of licensing do they require?

(A) A single state license issued exclusively by the Gujarat FSSAI office

(B) Basic entry-level FSSAI registrations for each individual physical plant

(C) Central FSSAI Licenses for their units and head office

(D) No formal license of any kind is required for cooperative dairy societies

2017

101. Which of the following pairs regarding FSSAI compliance documentation is correctly matched?

(A) Form D1 – Annual Return for dairy manufacturing units

(B) Form A – Official registration application for Central Licenses

(C) Form B – Official standard application for Basic Registration

(D) Schedule 4 – Legal maximum chemical residue limits for pesticides

2012

102. What is the legal effect of a dairy Food Business Operator (FBO) operating without a valid FSSAI license or registration?

(A) They are merely given a formal verbal warning by local food safety officers

(B) They are automatically granted an operational grace period of up to five years

(C) They must pay a slightly higher corporate income tax rate during financial audits

(D) They face penalties, fines, and potential imprisonment under the Act

2019

103. Given below are two statements, one labeled as Assertion (A) and the other as Reason (R).

Assertion (A): A dairy business operating strictly within a single state with a production capacity of 15,000 liters per day requires a State License, not a Central License.

Reason (R): Central Licenses are only ever issued to businesses involved in the import/export of food products.

(A) Both A and R are true and R is the correct explanation of A.

(B) Both A and R are true but R is not the correct explanation of A.

(C) A is true but R is false.

(D) A is false but R is true.

2008

104. What is a key regulatory advantage of the unified FSS Act, 2006 over the previous fragmented food laws (like the PFA Act, MMPO, etc.)?

(A) It completely abolished all physical safety standards to promote free global trade

(B) It legally mandated that all critical food safety testing must be done outside India

(C) It created a "single-window" system to regulate food businesses

(D) It permitted individual states to establish completely distinct and contradictory standards

2014

105. Which of the following historical orders or acts was NOT repealed and replaced by the FSS Act, 2006?

(A) Prevention of Food Adulteration (PFA) Act, 1954

(B) Milk and Milk Products Order (MMPO), 1992

(C) Meat Food Products Order (MFPO), 1973

(D) Essential Commodities Act, 1955

2001

106. According to FSSAI standards, what are the minimum required percentages for Milk Fat and Solid-Not-Fat (SNF) for "Toned Milk" throughout India?

(A) Fat 1.5%, SNF 9.0%

(B) Fat 3.0%, SNF 8.5%

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2003

138. Given below are two statements, one labeled as Assertion (A) and the other as Reason (R).
Assertion (A): AGMARK certification on a tin of Ghee assures the consumer of its exact quality grade and regional purity.
Reason (R): AGMARK grading integrates both physicochemical parameters (like RM value and Polenske value) and sensory attributes to classify agricultural commodities.
Select the correct answer from the options below:
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2006

139. Under the AGMARK standards for Ghee, what are the three recognized hierarchical grades indicative of quality?
(A) Gold, Silver, Bronze
(B) Special, General, Standard
(C) Grade 1, Grade 2, Grade 3
(D) Premium, Medium, Low

2016

140. Which specific chemical test is strictly mandated under AGMARK grading to ensure that Ghee has NOT been adulterated with Vanaspati (hydrogenated vegetable oil)?
(A) Phosphatase test
(B) Gerber test
(C) Baudouin test
(D) Methylene Blue Reduction test

2018

141. When analyzing Table Butter for AGMARK grading, what is the maximum legally permitted moisture content?
(A) 10.0%
(B) 16.0%
(C) 20.0%
(D) 25.0%

2002

142. Conceptually, why do AGMARK specifications for the Reichert-Meissl (RM) value of Ghee vary significantly across different states/regions in India?
(A) Because laboratory equipment calibration and measuring standards vary significantly by state
(B) Because different state testing laboratories employ completely different chemicals for the same test
(C) Because regional agro-climating conditions and cattle feeding practices alter milk fat composition
(D) Because regional pricing structures require artificial variations in standard fatty acid levels

2016

143. Which statement regarding the operational structure of AGMARK is correct?
(A) It is administered directly by the World Health Organization's international food safety committee
(B) It is administered by the Directorate of Marketing and Inspection under the Ministry of Agriculture
(C) It applies exclusively to synthetic industrial chemicals and non-agricultural manufacturing machinery
(D) It allows certification to be granted by private dairy plants independently without government oversight

2023

144. In classifying the analytical parameters for AGMARK grading of Ghee, which of the following is classified purely as a physical constant rather than a chemical index?
(A) Free Fatty Acid (FFA) percentage value
(B) Saponification value of the fat sample
(C) Polenske value of the volatile acids
(D) Butyro-Refractometer (BR) reading at 40°C

NODIA

2016

145. Match the AGMARK grade of Ghee in List I with its corresponding official certification label color in List II.
List I: Grade of Ghee
P. Special Grade
Q. General Grade
R. Standard Grade
S. Unclassified (Not an AGMARK grade)
List II: Label Color
1. Green Label
2. Red Label
3. Black Label (No label issued)
4. Chocolate/Brown Label
(A) P-2, Q-1, R-4, S-3
(B) P-4, Q-2, R-1, S-3
(C) P-2, Q-4, R-1, S-3
(D) P-1, Q-2, R-3, S-4

2009

146. Which of the following dairy products is an exception, as it is generally NOT a primary focus of the AGMARK certification scheme (which heavily emphasizes fats/oils/agricultural produce)?
(A) Clarified butter fat (Ghee)
(B) Creamery or pasteurized butter
(C) Synthetic non-dairy coffee creamer
(D) Blended agricultural fat spread

2010

147. If a batch of Ghee tested for AGMARK grading shows an unusually low Reichert-Meissl (RM) value and a high Polenske value, what adulteration practice can be logically inferred?
(A) Adulteration with fats containing high levels of insoluble volatile fatty acids
(B) Adulteration with pure water and chemical emulsifiers to increase physical volume
(C) Adulteration with starch, mashed potatoes, or cereal flours to mimic texture
(D) Adulteration with industrial cane sugar syrup to artificially alter sweetness

2001

148. The Hazard Analysis Critical Control Point (HACCP) system was originally pioneered in the 1960s by which entities to ensure food safety for space missions?
(A) World Health Organization, FAO, and several regional trade commissions
(B) The European Union Food Safety Authority and standard European agencies
(C) The International Dairy Federation and global milk quality research labs
(D) Pillsbury Company, NASA, and the United States Army Research Laboratories

2021

149. How many core foundational principles strictly define the HACCP framework as established by the Codex Alimentarius Commission?
(A) 5
(B) 7
(C) 9
(D) 12

2025

150. Which of the following correctly pairs the HACCP Principle number with its corresponding action?
(A) Principle 1 – Establish Corrective Actions
(B) Principle 3 – Establish Critical Limits
(C) Principle 6 – Conduct a Hazard Analysis
(D) Principle 7 – Determine Critical Control Points (CCPs)

2016

151. Conceptually, what is the role of Prerequisite Programs (PRPs) like GMP and sanitation standard operating procedures (SSOPs) in a HACCP plan?
(A) They are completely irrelevant and excluded from the implementation of modern HACCP protocols
(B) They replace the need to perform risk hazard assessments or establish Critical Control Points
(C) They focus strictly on corporate financial audits and labor optimization in the dairy plant
(D) They establish the essential hygienic and operational foundation needed for the HACCP plan

2025

152. Given below are two statements, one labeled as Assertion (A) and the other as Reason (R).
Assertion (A): Not every step in a dairy processing flow diagram where a hazard is present is designated as a Critical Control Point (CCP).
Reason (R): A CCP is only identified at steps where a control measure is absolutely essential to prevent, eliminate, or reduce a food safety hazard to an acceptable level, and where subsequent steps will not control the hazard.
Select the correct answer from the options below:
(A) Both A and R are true and R is the correct explanation of A.
(B) Both A and R are true but R is not the correct explanation of A.
(C) A is true but R is false.
(D) A is false but R is true.

2001

153. In a HACCP hazard analysis, how is the presence of Salmonella spp. in raw milk classified?
(A) As a physical hazard
(B) As a biological hazard
(C) As an allergenic hazard
(D) As a chemical hazard

2003

154. Which of the following is an INCORRECT statement regarding the difference between Verification and Validation in a HACCP system?
(A) Validation happens before or during the initial implementation to prove the plan will work
(B) Verification strictly involves redesigning the processing equipment from scratch annually

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(C) Verification involves ongoing activities (like auditing records and calibration) to ensure the plan is being followed
(D) Validation answers the question "Are we doing the right things?", while Verification answers "Are we doing things right?"

2002
155. What is the mandatory cause-and-effect procedural response when continuous monitoring indicates that the pasteurization temperature has dropped below the Critical Limit (e.g., dropped to 70°C instead of 72°C)?
(A) Divert the sub-standard milk using a flow diversion valve and apply corrective actions
(B) Ignore the temperature deviation entirely if the drop duration is less than five minutes
(C) Automatically accelerate the speed of the main milk pump to clear the processing line
(D) Change the final retail product packaging label to identify the batch as raw liquid milk

2021
156. Which of the following elements is strictly eliminated as being one of the 7 official principles of HACCP?
(A) Establish record-keeping and documentation procedures
(B) Establish monitoring procedures
(C) Establish a multi-million dollar marketing budget
(D) Establish verification procedures

2008
157. Comparing standard quality control and HACCP, what is the fundamental philosophical shift introduced by HACCP?
(A) Shifting from a proactive, preventive strategy to a reactive, end-product verification method
(B) Shifting from physical measurement of parameters to exclusive chemical analysis of samples
(C) Shifting from continuous automated processing lines to traditional manual operating methods
(D) Shifting from reactive, end-product testing to a proactive, preventive process-control model

2016
158. How does Codex Alimentarius precisely define a "Critical Limit" in HACCP?
(A) The maximum weight and physical cargo capacity that a bulk transport refrigerated truck can carry
(B) The geographic boundary line and security perimeter fence surrounding the dairy processing plant
(C) A scientific criterion separating acceptable from unacceptable hazard control limits at a CCP
(D) The maximum headcount of certified processing employees permitted on the factory floor per shift

2023
159. Match the specific dairy processing step in List I with the most likely corresponding hazard targeted for control at that step in List II.
List I: Processing Step
P. Raw milk reception screening
Q. Clarification/Filtration
R. HTST Pasteurization
S. Final Packaging and Metal Detection
List II: Hazard Targeted
1. Survival of vegetative pathogens (Biological)
2. Ferrous or non-ferrous particulate inclusions (Physical)
3. Antibiotic residues (Chemical)
4. Straw, hair, and visible dirt (Physical)
(A) P-3, Q-1, R-4, S-2
(B) P-3, Q-4, R-1, S-2
(C) P-4, Q-3, R-1, S-2
(D) P-1, Q-4, R-3, S-2

NODIA

2019
160. Conceptually, what tool is most universally recommended by Codex for objectively identifying Critical Control Points during the development of a HACCP plan?
(A) A comprehensive financial accounting spreadsheet detailing operational capital costs
(B) The CCP Decision Tree, using a logical sequence of questions at each process step
(C) A random mathematical number generator designed for unbiased sample selection processes
(D) A consumer preference and sensory evaluation survey conducted by external marketing firms

2011
161. Why is HTST pasteurization universally designated as a Critical Control Point (CCP) in liquid milk processing?
(A) Because it represents the least expensive utility and operational step within the entire plant

of how many Defects Per Million Opportunities (DPMO)?
(A) 3.4 DPMO
(B) 6.0 DPMO
(C) 100 DPMO
(D) 3400 DPMO

2005

192. What are the correct five phases of the classic Six Sigma improvement methodology used for existing processes?
(A) Define, Measure, Analyze, Improve, Control
(B) Design, Measure, Align, Implement, Check
(C) Do, Make, Analyze, Inspect, Correct
(D) Define, Measure, Analyze, Improve, Control

2004

193. Which of the following pairs regarding the DMAIC phases is INCORRECTLY matched?
(A) Analyze – Implementing the final solution and closing the project
(B) Define – Identifying the problem and project goals
(C) Measure – Collecting baseline data on current process performance
(D) Control – Sustaining the improvements through standard operating procedures

2013

194. Conceptually, when should a dairy engineering team utilize the DMADV (Design for Six Sigma) framework instead of DMAIC?
(A) When they need to slightly optimize the physical speed and efficiency of an active bottling line
(B) When they are required to conduct a routine, quarterly corporate financial and accounting audit
(C) When an existing process is fundamentally broken, or when designing a new process from scratch
(D) When the cleaning crew performs standard daily sanitation and maintenance inside storage silos

2021

195. In the organizational structure of a Six Sigma deployment, an expert who leads complex, cross-functional improvement projects full-time and mentors others is identified by which belt color?
(A) White Belt
(B) Yellow Belt
(C) Green Belt
(D) Black Belt

2004

196. What is the fundamental cause-and-effect principle driving Six Sigma's focus on reducing process variation (e.g., standardizing the exact filling volume of milk pouches)?
(A) Increased variation directly leads to much higher product consistency and physical package safety
(B) Highly reduced variation entirely eliminates the chemical and biological need for pasteurization
(C) Reducing variation systematically increases the mandatory number of operational factory workers
(D) Less variation reduces defect rates, waste, and material giveaway while boosting satisfaction

2005

197. Comparing DMAIC and DMADV, which final phase replaces "Control" when designing a new dairy process under DMADV?
(A) Correct
(B) Verify
(C) Validate
(D) Value

2022

198. During which phase of the DMAIC process would a team actively utilize statistical tools like Gage R&R (Measurement System Analysis) to ensure their milk-fat testing equipment is providing trustworthy data?
(A) Define
(B) Measure
(C) Improve
(D) Control

2024

199. Which of the following is eliminated as a standard statistical or analytical tool typically used within the Six Sigma framework?
(A) Ishikawa (Fishbone) Diagram
(B) Pareto Chart
(C) Control Charts (SPC)
(D) The AGMARK grading certificate

2006

200. What is a key organizational advantage of integrating Statistical Process Control (SPC) during the 'Control' phase of a Six Sigma project in a dairy?
(A) It lets operators monitor processes in real-time and fix issues before defects occur
(B) It permanently eliminates the operational necessity for executive and middle

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2010

168. Who is the most appropriate entity to develop and implement a robust HACCP plan in a large dairy processing facility?
(A) A single, recently recruited student intern operating without any external supervision
(B) The external marketing and public relations agency managing the corporate brand campaigns
(C) The local municipal water utility authority responsible for regional sanitation guidelines
(D) A multidisciplinary team of quality, production, engineering, and maintenance experts

2001

169. What does the acronym QMS fundamentally stand for in the context of ISO 9001?
(A) Quality Management System
(B) Quantity Measurement System
(C) Quick Manufacturing Standard
(D) Quota Maximization Strategy

2014

170. As of current global standards, which is the latest revised version of the ISO 9001 standard?
(A) ISO 9001:1987
(B) ISO 9001:2000
(C) ISO 9001:2008
(D) ISO 9001:2015

2011

171. The operational structure of ISO 9001 is heavily based on which continuous improvement cycle?
(A) Plan-Do-Check-Act (PDCA) cycle
(B) DMAIC cycle
(C) Krebs cycle
(D) DMADV cycle

2022

172. Which of the following is an INCORRECT statement regarding the scope and nature of ISO 9001?
(A) It is a generic standard applicable to any organization, regardless of its size or the product it provides
(B) It focuses heavily on customer satisfaction and meeting customer requirements
(C) It specifically mandates the exact fat and SNF percentages for dairy products
(D) It employs a process-based approach

2014

173. Conceptually, how does the ISO 9001 principle of "Customer Focus" practically manifest in a dairy organization?
(A) By disregarding all negative feedback and consumer complaints regarding sour pasteurized milk
(B) By restricting distribution channels and selling exclusively to one large regional distributor
(C) By focusing entirely on reducing internal production costs without considering milk taste profiles
(D) By assessing satisfaction, understanding buyer needs, and seeking to exceed expectations

NODIA

2015

174. In ISO 9001 terminology, tracking the reduction of packaging defects month-over-month is an identification of which core quality management principle?
(A) Engagement of people
(B) Relationship management
(C) Continuous improvement
(D) Evidence-based decision making

2021

175. What is the direct cause-and-effect requirement when an internal auditor identifies a "Non-conformity" during an ISO 9001 audit of a dairy plant?
(A) The external auditing specialist manually repairs the mechanical and processing equipment themselves
(B) The plant must analyze the root cause and implement corrective actions to prevent recurrence
(C) The regulatory authorities issue an order to shut down the processing facility permanently
(D) The auditor updates the official standard specifications to align with the non-compliant process

2004

176. Under ISO 9001:2015, how is the classification of mandatory paperwork handled?
(A) It enforces the mandatory production of thick, rigid Quality Manuals following the older standards
(B) It strictly bans the utilization of modern digital records, requiring physical paper documentation
(C) It mandates that all internal operational records must be printed weekly in local public newspapers
(D) It uses "Documented Information," giving organizations flexibility in record formats

(B) Because it completely filters out and extracts heavy metal contaminants dissolved in raw milk
(C) Because it chemically enhances the natural vanilla flavor profile and aroma of the finished milk
(D) Because it is a step where control is applied to eliminate or reduce pathogens to safe levels

2007

162. For the CCP of continuous HTST pasteurization, which of the following represents the most standard and critical monitoring procedures?
(A) Continuous automated recording of pasteurization temperature and holding flow rates
(B) Periodic sensory tasting and visual appearance evaluations of the processed milk every hour
(C) Dispatching finished pasteurized milk samples to external labs for 48-hour agar plate cultures
(D) Visual estimation of the analog boiler steam pressure gauges located on the main production floor

2003

163. Which statement correctly describes a valid Corrective Action for a metal detector CCP that rejects a packaged block of cheese?
(A) Put the rejected cheese block back into the conveyor stream to verify if it can pass a second test cycle
(B) Temporarily bypass and turn off the active metal detection system to prevent any further production delays
(C) Isolate the package, test the detector calibration, investigate the source, and handle the product safely
(D) Ship the rejected cheese packages immediately to alternative foreign markets that permit higher metal thresholds

2017

164. In an ice cream manufacturing facility, passing the final packaged product through an inline metal detector is classified as what specific HACCP component?
(A) A Critical Control Point (CCP) to control physical hazards
(B) A baseline Prerequisite Program (PRP) for sanitation
(C) A mandatory Good Agricultural Practice (GAP) guideline
(D) A biological verification and microbial screening step

2017

165. If raw milk is chilled immediately after milking to 4°C, and this step is designed to prevent the rapid multiplication of psychrotrophic bacteria but cannot eliminate them, what is the logical HACCP inference for this step?
(A) It serves as the definitive final Critical Control Point for complete pathogenic elimination
(B) It is considered completely redundant and unnecessary for modern industrial milk processing
(C) It acts as an aggressive thermal sterilizer that actively destroys all bacterial endospores
(D) It is a control measure, often classified as a CCP or PRP, focused on minimizing hazard growth

2008

166. What is a key practical advantage of the strict record-keeping principle applied to CCP monitoring in a dairy plant?
(A) It permits the processing plant to significantly reduce baseline wages and labor overheads
(B) It provides documented proof of process control and due diligence during safety audits
(C) It entirely eliminates the operational necessity for manual physical cleaning of the facility
(D) It accelerates the mechanical holding speed during continuous high-temperature pasteurization

2012

167. What is the immediate consequence of utilizing an inaccurate or outdated process flowchart during the preliminary steps of HACCP plan development?
(A) The processed milk will naturally undergo biochemical shifts and taste slightly sweeter to consumers
(B) The production plant will automatically qualify for and upgrade to international ISO 22000 status
(C) Significant hazards linked to undocumented steps may be completely overlooked in the hazard analysis
(D) There are no real-world operational consequences, as flowcharts are viewed as purely decorative tools

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2005

184. In comparing ISO 9001 to ISO 22000 for a dairy plant, which is the most accurate distinction?

(A) ISO 9001 focuses on general quality and satisfaction, whereas ISO 22000 manages food safety hazards

(B) ISO 9001 applies exclusively to meat processing sectors, whereas ISO 22000 is designed solely for milk

(C) ISO 9001 mandates comprehensive analytical laboratory testing, whereas ISO 22000 requires no testing

(D) ISO 22000 was originally published in the year 1980, whereas ISO 9001 was first introduced in 2018

2022

185. In an ISO 22000 dairy implementation, specific prerequisite programs (PRPs) such as pest control, personnel hygiene, and sanitization are typically guided by which technical specification document series?

(A) ISO 14001 environmental standards series

(B) ISO/TS 22002 technical specification series

(C) OHSAS 18001 occupational safety guidelines

(D) FSSAI Form-B licensing application template

2019

186. If a new virulent strain of a pathogen is discovered to survive standard pasteurization temperatures, what logical inference dictates the dairy plant's response under ISO 22000?

(A) The facility must hide the raw microbial laboratory data from certification surveillance auditors

(B) The plant must update the FSMS, reassess the hazards, and modify relevant control measures

(C) The management team must immediately modify the packaging colors to notify external consumers

(D) The plant must completely halt liquid processing and switch to manufacturing only dry milk powder

2002

187. What is the intended cause-and-effect result of implementing "Emergency preparedness and response" procedures under ISO 22000?

(A) To ensure the plant can manage unforeseen emergencies without compromising finished food safety

(B) To significantly increase overall profit margins and wholesale product prices during market crises

(C) To conduct physical training sessions teaching employees hand-to-hand defensive combat skills

(D) To temporarily bypass standard high-temperature pasteurization protocols during peak supply hours

2010

188. Which of the following is an exception, as it is NOT a required core component of a Food Safety Management System (FSMS) as outlined in ISO 22000?

(A) Prerequisite programs (PRPs)

(B) System management and continual improvement

(C) A mandatory minimum profit target for the fiscal year

(D) Hazard Analysis and Critical Control Plan (HACCP)

2005

189. Before officially adopting a new non-thermal processing technique to replace pasteurization in an ISO 22000 certified plant, what is the most appropriate mandatory step regarding the new control measure?

(A) Launching an immediate consumer marketing and public advertising campaign

(B) Performing routine verification checks on unrelated packaging metal detectors

(C) Firing and replacing the existing certified high-temperature pasteurizer operators

(D) Validation of the process, ensuring scientific proof of effective hazard control

2019

190. How is Six Sigma technically defined in the context of process quality improvement?

(A) An organizational method focused exclusively on increasing annual employee vacation and break times

(B) A stylized creative framework developed purely for aesthetic graphic design and product brand layouts

(C) A disciplined, data-driven method using statistical tools to reduce defects and process variation

(D) A mandatory national food safety regulatory law officially passed and enforced by the FSSAI council

2014

191. In statistical terms, a process operating at a true "Six Sigma" quality level produces a maximum

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2009

208. Comparing TQM to traditional Quality Control (QC), what is the most defining difference?
(A) QC focuses exclusively on process flowcharts, whereas TQM is designed to evaluate only finished products
(B) QC operates as a proactive and preventive quality strategy, whereas TQM is entirely reactive and inspection-based
(C) QC is applied solely to raw and processed liquid milk, whereas TQM is reserved exclusively for cheese varieties
(D) QC relies on final inspection of defects, whereas TQM builds quality into every stage of the process

2017

209. Which of the following elements is NOT considered a core element of the TQM philosophy?
(A) Tolerating a steady baseline of defects
(B) Fact-based managerial decision making
(C) Strategic and systematic process models
(D) Continual, incremental improvements

2013

210. What is the most appropriate role for top-level leadership when initiating TQM in a large dairy cooperative?
(A) Delegating the entire implementation to the laboratory supervisor and ignoring further progress
(B) Focusing leadership efforts purely on visual aspects such as promotional marketing brochure designs
(C) Providing visible commitment, defining the vision, aligning resources, and leading quality efforts
(D) Creating a culture of fear by immediately terminating any employee who makes a minor processing error

2019

211. What is the primary factual goal of Lean Manufacturing methodologies when applied to a dairy processing environment?
(A) To relentlessly identify and eliminate waste from processes to maximize customer value
(B) To strictly maximize the physical weight and overall density of finished consumer dairy products
(C) To systematically increase the total headcount of manual, unautomated assembly line workers
(D) To ensure that massive, high-volume stockpiles of packaging materials are maintained at all times

2005

212. What are the correct five components of the standard "5S" workplace organization method derived from Lean?
(A) Sort, Set in order, Shine, Standardize, Sustain
(B) Sweep, Scrub, Sanitize, Store, Save
(C) Select, Systematize, Study, Solve, Share
(D) Start, Stop, Slow, Speed, Shift

2011

213. Which statement accurately describes the Lean concept of "Kaizen"?
(A) A massive, high-capital engineering project aimed at total factory demolition and rebuild
(B) A philosophy of continuous, incremental improvement involving all levels of workforce
(C) The specialized administrative process of auditing corporate tax returns and financial sheets
(D) A specific Japanese brand of pasteurizer plate heat exchangers

2007

214. Conceptually, what does the Lean tool "Poka-Yoke" mean in a dairy packaging line?
(A) A standard statistical control chart used to trace daily chemical variations in pasteurized milk
(B) An automated mechanical method designed to accelerate the cycling speeds of filling machinery
(C) Mistake-proofing steps so that human processing errors are made impossible or immediately clear
(D) A structured team-building and physical communication exercise conducted weekly for floor workers

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2007

215. In the context of Lean, if a dairy plant suffers from uneven, erratic production schedules that heavily strain workers and machines, which specific Japanese term identifies this type of operational waste?
(A) Muda (Non-value adding waste)
(B) Muri (Overburden / Unreasonableness)
(C) Kanban (Visual signal)
(D) Mura (Unevenness / Inconsistency)

2010

216. What is the intended cause-and-effect dynamic of implementing a "Just-In-Time" (JIT) material flow strategy in dairy packaging?

management
(C) It provides a biochemical process that allows the plant to utilize expired raw milk safely
(D) It entirely replaces and nullifies the legal necessity for a national FSSAI license

2004
201. How is Total Quality Management (TQM) best defined?
(A) A narrow, isolated administrative department focused exclusively on testing end-product batches
(B) An organization-wide philosophy centered on continuous improvement and total worker involvement
(C) A rigid, non-negotiable set of international government trade and manufacturing regulations
(D) A corporate strategy designed to maximize immediate financial gains through widespread staff layoffs

2002
202. Which renowned quality pioneer is famous for formulating the "14 Points for Management," which form the foundation of many TQM programs?
(A) Joseph M. Juran
(B) W. Edwards Deming
(C) Philip Crosby
(D) Kaoru Ishikawa

2014
203. A fundamental pillar of TQM is "Employee Empowerment." What does this factually entail on a dairy processing floor?
(A) Giving operators the training, tools, and authority to stop production if a defect is found
(B) Granting manufacturing floor workers the explicit legal authority to ignore sanitary rules
(C) Compensating processing plant employees directly with bulk dairy products instead of wages
(D) Ensuring that senior plant executives make every single daily micro-decision on the floor

2018
204. Which of the following is an INCORRECT statement regarding the "Cost of Quality" concept in TQM?
(A) Prevention costs (e.g., training, maintenance) are investments made to keep defects from occurring
(B) Appraisal costs include laboratory testing and inspections
(C) High external failure costs (e.g., recalls, lawsuits) are desirable because they generate free publicity
(D) Internal failure costs (e.g., rework, scrap) occur before the product reaches the customer

2012
205. In TQM philosophy, what does the concept of the "Internal Customer" refer to within a dairy plant?
(A) Plant employees who are permitted to consume finished dairy products during active shift hours
(B) Retail consumers who physically reside in housing structures located inside the dairy farm limits
(C) The specialized internal quality auditing and financial bookkeeping teams within the company
(D) Recognizing that each department is a customer to the preceding step and deserves high quality

2010
206. The TQM framework known as the "Juran Trilogy" categorizes quality management into which three distinct universal processes?
(A) Quality Planning, Quality Control, and Quality Improvement
(B) Quality Definition, Quality Measurement, and Quality Analysis
(C) Plan, Do, Check
(D) Sort, Set in order, Shine

2011
207. What is a primary cause-and-effect consequence of a successful TQM implementation in a traditional dairy organization?
(A) A massive, uncontrolled increase in end-product waste and raw materials discarded on the floor
(B) A cultural shift from reactive "detect and fix" to proactive "prevent and improve" at all levels
(C) A complete and total reliance on the specialized Quality Control manager to perform all auditing
(D) A deliberate and planned reduction in the overall microbial shelf-life of finished liquid milk

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and mediums

2018

177. Match the ISO 9001:2015 high-level structure Clause in List I with its core focus area in List II.

List I: ISO 9001:2015 Clause

P. Clause 4
Q. Clause 5
R. Clause 8
S. Clause 9

List II: Focus Area

1. Performance Evaluation (Internal audits, management review)
2. Operation (Production and service provision)
3. Context of the Organization
4. Leadership (Commitment and policy)

(A) P-2, Q-4, R-1, S-3
(B) P-3, Q-4, R-2, S-1
(C) P-3, Q-1, R-4, S-2
(D) P-4, Q-3, R-1, S-2

2018

178. Which of the following concepts is an exception, as it is NOT recognized as one of the seven official Quality Management Principles underpinning ISO 9001?

(A) Leadership commitment
(B) Process-oriented approach
(C) Maximizing short-term profit
(D) Evidence-based decision making

2015

179. If top management at a dairy cooperative holds an annual meeting to review audit results, customer feedback, and process performance to ensure the QMS remains aligned with strategic direction, what ISO 9001 process are they executing?

(A) Management Review
(B) Initial Calibration
(C) Product Dispatch
(D) Basic Registration

2022

180. What is the specific title and focus of the ISO 22000 standard?

(A) Environmental Management Systems regulating industrial processing waste emissions
(B) Occupational Health and Safety guidelines protecting processing plant employees
(C) Information Security Management safeguarding proprietary digital business databases
(D) Food Safety Management Systems (FSMS) requirements across the entire food chain

2021

181. ISO 22000 is uniquely powerful for the food industry because it formally integrates which two major established methodologies?

(A) Advanced Six Sigma statistical tools merged with cellular and Lean Manufacturing flow patterns
(B) Standard HACCP principles and prerequisite programs integrated with the ISO 9001 QMS structure
(C) Double-entry corporate financial accounting practices aligned with human resource allocation
(D) Commercial marketing and graphic branding concepts coupled with packaging design guidelines

2021

182. Which statement correctly identifies a unique core element of ISO 22000 that ensures food safety hazards are identified and controlled adequately across the entire supply chain?

(A) Corporate isolationism that prevents sharing production data with external municipal authorities
(B) Operational cost-cutting to minimize raw material expenses regardless of safety implications
(C) Interactive communication across internal and external stakeholders both upstream and downstream
(D) Relying exclusively on manual labor instead of modern computerized food processing systems

2004

183. Conceptually, how does an Operational Prerequisite Program (OPRP) differ from a Critical Control Point (CCP) under the ISO 22000 framework?

(A) OPRPs apply exclusively to administrative accounting steps, whereas CCPs manage physical food safety hazards
(B) OPRPs are implemented only at the primary dairy farm level, whereas CCPs are used strictly at retail points
(C) There is no difference between the two concepts as both terms are perfectly synonymous in food legislation
(D) CCPs have strict measurable critical limits, while OPRPs utilize action criteria without real-time limits

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(A) Receiving packaging materials only as needed, cutting storage costs and inventory obsolescence
(B) Receiving raw materials long after they are actively scheduled, causing complete production halts
(C) Processing liquid milk at maximum mechanical speeds regardless of real-world commercial consumer demand
(D) Accumulating massive storage silos of raw milk with no immediate processing capacity or facility space

2009

217. Which of the following pairs linking the Japanese 5S term to its English equivalent is INCORRECTLY matched?
(A) Seiri – Sort
(B) Seiton – Set in Order
(C) Seiso – Shine
(D) Shitsuke – Standardize

2009

218. When comparing Lean Manufacturing to Six Sigma, how do their primary operational focuses differ?
(A) Six Sigma focuses entirely on speed and waste elimination, whereas Lean works to reduce quality variations
(B) Lean cuts waste and improves flow, whereas Six Sigma reduces process variation and boosts precision
(C) Lean applies exclusively to administrative office environments, whereas Six Sigma is meant for factories
(D) There are absolutely no conceptual differences, as they operate as identical tools with different names

2010

219. According to the classic 8 Wastes of Lean (DOWNTIME), which of the following is an exception, NOT classified as a form of manufacturing waste?
(A) Defect-free, value-added processing
(B) Manufacturing of excess overproduction
(C) Idle waiting times during machine cycles
(D) Unutilized employee talent and skills

2023

220. What is a key advantage of utilizing Value Stream Mapping (VSM) during a Lean dairy transformation?
(A) It automatically generates and scales the chemical recipes for manufacturing new cheese varieties
(B) It introduces renewable energy methods that completely eliminate the plant's electricity costs
(C) It visually maps materials and information from supplier to consumer, exposing bottlenecks and waste
(D) It utilizes computerized sonic waves that automatically clean pasteurization plate heat exchangers

2024

221. What does the acronym GFSI stand for in the global food safety and dairy trade context?
(A) General Food Standards Institute
(B) Global Farming and Sanitation Integration
(C) Government Food Security Inspection
(D) Global Food Safety Initiative

2007

222. The highly recognized FSSC 22000 certification scheme is fundamentally built upon a combination of which established standards?
(A) Traditional ISO 9001 quality guidelines combined with ISO 14001 ecological rules
(B) Standard HACCP principles merged with the specific regional municipal safety codes
(C) ISO 22000 combined with sector-specific PRPs and additional FSSC requirements
(D) The United States Food and Drug Administration (FDA) national Food Code regulations

2003

223. What does SQF, a major GFSI-recognized scheme often applied in dairy operations, stand for?
(A) Standard Quality Framework
(B) Safe Quality Food
(C) Sanitary Quality Facilities
(D) System for Quality Farming

2006

224. Which statement correctly describes the BRC (British Retail Consortium) Global Standard for Food Safety?
(A) It represents a local standard that remains entirely unrecognized outside the United Kingdom
(B) It operates purely to regulate the commercial marketing and advertising standards of foods
(C) It has been legally replaced in the global market by basic national FSSAI food registrations
(D) It is a GFSI scheme focused on management

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commitment, HACCP, and facility prerequisites

2023

225. Conceptually, what is the core purpose of the "benchmarking process" conducted by the GFSI?
(A) To evaluate food safety schemes against standard criteria to ensure equivalent safety assurance
(B) To establish and enforce the exact pricing structure for fluid milk traded on international markets
(C) To plan and draft standard ergonomic blueprints for physical laboratory workbenches and desks
(D) To evaluate and score the physical activity, health, and fitness levels of active dairy cattle

2007

226. What critical auditing mechanism, strongly enforced by GFSI-recognized schemes like FSSC 22000 and BRC, is designed to ensure constant "audit readiness" and genuine everyday compliance in a dairy plant?
(A) Standard, scheduled quality audits performed only once every five years
(B) Self-audits conducted independently by the plant manager without oversight
(C) Mandatory unannounced surprise audits integrated into the certification cycle
(D) Document reviews and audits conducted strictly over the telephone networks

2002

227. What is a massive cause-and-effect benefit for a large dairy exporter achieving a GFSI-recognized certification (like FSSC 22000)?
(A) It eases global market access by satisfying retail safety rules and avoiding multiple audits
(B) It implements logistics strategies that entirely eliminate international product transport costs
(C) It completely removes any legal requirement to comply with domestic national FSSAI regulations
(D) It forces processing plants to lower their baseline product quality to meet global benchmarks

2002

228. Comparing ISO 22000 alone versus FSSC 22000, why do global retailers often demand FSSC 22000 instead of just ISO 22000?
(A) Because standard ISO 22000 is classified as an illegal framework under international trade laws
(B) Because FSSC 22000 is significantly less complex and requires no formal documentation procedures
(C) Because standard ISO 22000 specifically bans and excludes the certification of dairy products
(D) ISO 22000 lacks the specific prerequisite requirements needed for GFSI benchmarking status

2023

229. Which of the following is a strict exception, as it is generally NOT a GFSI-benchmarked/ recognized food safety certification scheme?
(A) Safe Quality Food (SQF) certification
(B) Basic local city health department GMPs
(C) BRC Global Standard food safety scheme
(D) FSSC 22000 food certification framework

2024

230. When a massive global supermarket chain mandates that all its private-label dairy suppliers must hold a GFSI-recognized certificate, this is the most appropriate illustration of:
(A) Excessive international government overreach into standard municipal dairy operations
(B) A direct legal violation of established bilateral free trade and transport agreements
(C) Retailer-driven supply chain safety rules enforcing global standards beyond basic regulations
(D) Global corporate green environmental and sustainable agricultural farming practices

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ANSWERS

1. (B) A combination of chemical, physical, and hygienic attributes meeting regulatory standards
Milk quality represents a comprehensive concept in the dairy industry, encompassing chemical composition like fat and protein levels, physical properties such as color and density, and essential hygienic standards including low bacterial and somatic cell counts. These combined parameters ensure that the milk is safe for consumption, legally compliant, and suitable for processing.

2. (D) It involves preventing physical, chemical, and biological hazards to protect consumers
Milk safety focus lies in protecting consumers from harm by implementing systematic controls throughout the supply chain. This process involves identifying and preventing potential hazards, which are classified into physical contaminants like glass, chemical residues such as antibiotics or pesticides, and biological agents including pathogenic bacteria, ensuring the final dairy product is entirely safe.

3. (A) Pre-milking teat dipping and proper udder sanitization
Sanitizing the udder and practicing pre-milking teat dipping serve as the primary barriers against bacterial entry into the milk canal. These hygienic protocols effectively remove environmental pathogens, dirt, and organic matter from the teat surface before milking begins, significantly reducing the initial microbial load of raw milk and preventing mastitis transmission within dairy herds.

4. (C) Lactose crystallization rate
Keeping quality indicates how long raw milk remains sweet and usable. Titratable acidity measures sourness development, somatic cell count reflects udder health and milk stability, and methylene blue reduction time indicates overall bacterial activity. Lactose crystallization rate, however, is a physical phenomenon relevant to concentrated dairy powders or condensed milk storage rather than raw milk quality assessments.

5. (A) Both A and R are true and R is the correct explanation of A.
Hygienic milking practices directly limit the entry of spoilage bacteria into raw milk. A lower initial microbial population means that bacteria require a longer lag phase before they can actively multiply, consume lactose, and produce lactic acid. Therefore, preventing contamination directly retards the biochemical processes of spoilage, proving both statements true with a direct causal relationship.

6. (D) To destroy Coxiella burnetii, the most heat-resistant non-spore-forming pathogen in milk
High-Temperature Short-Time pasteurization, typically operating at seventy-two degrees Celsius for fifteen seconds, is scientifically designed to ensure milk safety. Its primary regulatory and biological target is the destruction of Coxiella burnetii, which causes Q fever. Being the most heat-tolerant non-spore-forming pathogen found in raw milk, its inactivation guarantees the destruction of other common pathogens.

7. (B) Proliferation of psychrotrophic bacteria producing heat-stable enzymes
Chilling milk to four degrees Celsius inhibits normal mesophilic bacteria but allows psychrotrophic microorganisms to multiply if initial hygiene is poor. These cold-tolerant bacteria, primarily Pseudomonas species, produce extracellular lipases and proteases during low-temperature storage. These enzymes are highly heat-stable, surviving pasteurization and subsequently causing bitter flavors and physical defects in finished dairy products.

8. (C) These natural systems completely sterilize raw milk stored at room temperature
Fresh raw milk possesses innate, protective antimicrobial components including lactoferrin, lysozyme, and the lactoperoxidase system, which inhibit or kill specific bacteria. However, these natural defensive systems only provide temporary bacteriostatic or mild bactericidal effects. They cannot completely sterilize the milk or prevent spoilage, particularly when the product is stored at elevated, ambient room temperatures.

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9. (D) Inflammatory response in the udder caused by mastitis
Somatic cells in milk consist mainly of white blood cells and some epithelial cells. When a dairy cow develops mastitis, which is an inflammatory reaction of the mammary gland tissue, the animal's immune system rapidly deploys leukocytes to the udder to fight the infection. This physiological immune response causes a sharp increase in somatic cell counts.

10. (A) Coliform count on equipment surfaces
Coliform bacteria serve as highly reliable indicator organisms for evaluating hygiene and sanitation standards in food facilities. Their presence on cleaned product-contact surfaces of pasteurizers, pipes, or vats directly indicates poor cleaning, inadequate sanitization, or post-sanitization environmental contamination. Monitoring coliform counts on machinery surfaces helps verify the effectiveness of sanitation standard operating procedures.

11. (B) Infected udders of dairy cattle
Staphylococcus aureus is a major contagious pathogen responsible for clinical and subclinical bovine mastitis. The bacterium resides inside infected mammary tissues, teat canals, and udder lesions of dairy cows. During milking, these pathogens are directly shed from the interior of the infected udder into the milk stream, making animal health the primary endogenous contamination route.

12. (B) P-3, Q-1, R-4, S-2
Dairy contaminants map directly to their primary origins. Aflatoxin M_1 arises when cows ingest feed containing mold-produced Aflatoxin B_1. Psychrotrophic bacteria thrive in cold conditions, pointing to poorly sanitized bulk coolers. Organochlorines originate from persistent agricultural pesticide applications in grazing areas. Antibiotic residues stem from veterinary treatments for mastitis where withdrawal periods are ignored.

13. (A) Lubricant leaks from equipment – Chemical hazard
Contaminants in dairy processing are categorized into physical, chemical, and biological hazards. Lubricants, sanitizing chemicals, and machine oils leaking from processing equipment represent direct chemical hazards because they introduce non-food-grade chemical formulations into the milk stream. Conversely, peeling paint is a physical hazard, and active bovine mastitis infections introduce biological pathogens.

14. (C) Contaminated farm water used for washing utensils and udders
Agricultural runoff, fertilizer leaching, and animal waste decomposition frequently contaminate shallow groundwater systems with both chemical nitrates and biological coliform bacteria. If this compromised water supply is utilized on the dairy farm for cleaning milking utensils or washing animal udders, it serves as a dual contamination vector, transferring both hazards into the raw milk.

15. (D) Environmental heavy metals
Exogenous contaminants originate entirely outside the animal's body and are introduced from the surrounding environment. Toxic heavy metals, including lead and cadmium, represent classic exogenous chemical hazards that enter the milk supply chain through polluted soil, industrial water runoff, or contaminated crop feed, contrasting with endogenous components naturally synthesized or found inside the cow's mammary system.

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16. (C) Human handling introduces Salmonella/ Shigella, while biofilms harbor Listeria/ Pseudomonas
The contamination profile varies based on the vector. Direct human contact primarily introduces enteric and foodborne human pathogens like Salmonella or Shigella due to inadequate personal hand hygiene. In contrast, persistent biofilms formed on stainless steel surfaces provide a protective microenvironment where environmental, cold-tolerant, and cleaning-resistant bacteria, such as Listeria monocytogenes and Pseudomonas species, can establish and thrive.

17. (B) Glass shard contamination
Physical hazards refer to any extraneous physical object causing choking or internal injury. Maintaining glass instruments in contact with food creates a high risk of structural breakage. If a glass thermometer cracks or breaks inside a milk silo, it directly introduces sharp glass shards into the liquid, creating a severe physical safety risk.

18. (D) Adhering strictly to mandatory drug withdrawal periods
Veterinary medicines require a specific duration to clear from a dairy animal's system. Adhering to the mandatory drug withdrawal period ensures that milk is not collected for human consumption until antibiotic levels fall below legal safety limits. Thermal processing, pasteurization, or normal filtration cannot destroy or remove these heat-stable chemical residues, making on-farm compliance the only effective control.

19. (C) I and II
Adding extraneous water is a common adulteration practice that frequently introduces environmental psychrotrophic pathogens into raw milk. Additionally, milk stone, which is a deposit of calcium phosphate and milk proteins on processing equipment, provides a protective matrix and nutrient source for thermoduric bacteria. High-urea feed actually increases milk urea nitrogen levels, making statement three incorrect.

20. (C) Using 304 or 316 stainless steel on food-contact surfaces
Using grade 304 or 316 stainless steel for food-contact surfaces prevents chemical migration of heavy metals into dairy products. These alloys are highly corrosion-resistant, structurally durable, and chemically inert, ensuring they do not react with acidic milk components like lactic acid. Conversely, copper, brass, or lead-soldered vessels leach hazardous metals into milk, posing severe health risks.

21. (A) Prerequisite basic hygienic conditions and practices for food safety
Good Hygiene Practices comprise the foundational, preventive procedures required to maintain a sanitary environment throughout the food chain. In dairy systems, these encompass basic standards like personal hygiene, clean water, pest control, and proper waste management. These operations act as essential prerequisites for implementing a hazard analysis critical control point system to guarantee consumer safety.

22. (D) Design and maintenance of premises, equipment, and process controls
Good Manufacturing Practices in a dairy processing facility focus on establishing structural, operational, and process integrity. This includes the hygienic design of the plant layout, selection of non-corrosive machinery, maintenance of equipment, and systematic control of processing parameters like heating and cooling. These elements together establish a controlled environment that minimizes product contamination risks.

23. (B) Pre-rinse, alkali wash, intermediate rinse, acid wash, final rinse, sanitization
An effective Clean-In-Place cycle follows a precise chemical sequence to clean pipelines internally. The initial pre-rinse flushes loose milk solids. Next, hot alkali wash saponifies fat and dissolves protein residues, followed by an intermediate rinse. An acid wash then removes mineral scales and milk stone, preceding a final rinse and sanitization to eliminate remaining viable bacteria.

24. (C) To separate raw and pasteurized product areas to prevent contamination
Zoning within dairy processing facilities represents a crucial sanitary design measure. By dividing the plant into distinct physical areas and restricting movement between them, it segregates raw milk receiving zones from pasteurized processing and packaging areas. This spatial separation successfully prevents cross-contamination, ensuring that pathogens from raw milk cannot contact ready-to-eat pasteurized products.

25. (D) Inability to remove mineral deposits and milk stone
The acid wash step in a Clean-In-Place system is specifically designed to dissolve mineral scales, primarily calcium phosphate, which accumulate as milk stone on heated equipment surfaces. Nitric acid acts as a powerful solubilizing agent. If the concentration is insufficient, the chemical reaction is incomplete, leaving mineral deposits and milk stone intact, which later harbor bacterial spores.

26. (B) I and III
Good Manufacturing Practices mandate specific structural controls. Statement one is incorrect because open processing windows must have functional insect screens to prevent physical and biological pests. Statement three is also incorrect because adequate lighting is mandatory throughout the entire facility to facilitate proper inspection, cleaning, and processing, while

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residues. Attempting to process contaminated milk into retail UHT milk to bypass food safety regulations is illegal and unsafe. Acceptable management strategies are limited to discarding the contaminated product or diverting it under strict protocols to feed young on-farm livestock.

63. (D) Bacillus stearothermophilus var. calidolactis
The Delvotest SP-NT assay is a standardized microbiological inhibition test designed to screen for antibiotic residues in milk. The test utilizes the highly sensitive thermophilic spore-former Bacillus stearothermophilus variety calidolactis as its indicator organism. If antibiotics are present in the milk sample, they inhibit the growth and acid production of this bacterium during the heated incubation phase.

64. (C) Lateral flow receptor assay
The Charm ROSA test represents a highly rapid screening tool used at raw milk receiving docks. It operates on the principle of a lateral flow receptor assay, utilizing specific binders or antibodies mounted on a test strip. These target receptors selectively bind to antibiotic families present in the milk sample, generating distinct visual test lines via capillary action flow.

65. (B) The Charm test targets specific drug families, while Delvotest is broad-spectrum
The lateral flow Charm test utilizes targeted antibodies or specific biological receptors, allowing it to rapidly detect specific families of drugs like beta-lactams within minutes. In contrast, the Delvotest is a microbial inhibition assay that relies on the metabolic activity of living bacterial spores, making it a broad-spectrum screening tool that takes several hours to yield results.

66. (D) Delvotest – Color change from purple to yellow when negative
The Delvotest uses an agar medium containing the pH indicator bromocresol purple. If raw milk is free of antibiotics, Bacillus stearothermophilus spores grow and produce acid, lowering the pH and changing the agar color from purple to yellow. If antibiotic residues are present, bacterial growth is inhibited, and the test agar remains purple, representing a positive result.

67. (B) 2.5 to 3 hours at 64°C
Microbial inhibition assays like the Delvotest require specific incubation parameters to support the metabolic activity of Bacillus stearothermophilus. The standard protocol dictates heating the test vials to sixty-four degrees Celsius, which is the optimal temperature for this thermophile. This temperature is maintained for two and a half to three hours to allow metabolic acid production to occur.

68. (B) II
Rapid lateral flow tests are designed primarily as qualitative or semi-quantitative screening tools. They indicate whether an antibiotic family is present above a specific threshold but cannot provide exact quantitative concentrations down to parts-per-billion levels for multiple drugs simultaneously, making statement two incorrect. Statements one and three represent well-documented technical limitations of these rapid assays.

69. (A) Competitive immunoassay
A competitive immunoassay relies on chemical competition between labeled drug molecules added during the test and unlabeled drug residues present in the milk sample. Both compete for a limited number of active binding sites on specific antibodies or receptors. Measuring the resulting level of bound labeled molecules allows the detection and quantification of antibiotic contamination.

70. (D) The milk contains high levels of natural antimicrobials from colostrum
Microbial inhibition assays rely on the growth of a test bacterium. Colostrum and early-lactation milk naturally contain elevated concentrations of innate antimicrobial proteins, such as lactoferrin, lysozyme, and immunoglobulins. These biological defenses can inhibit the growth of Bacillus stearothermophilus in the assay, causing a false positive color change even when pharmaceutical antibiotic residues are completely absent.

71. (B) The test has a lower sensitivity threshold or cross-reacted
The rapid screening test's positive result at a concentration lower than its nominal four parts-per-billion limit indicates that the assay possesses a lower detection threshold than stated. Alternatively, the antibodies on the test strip may have cross-reacted with structurally similar chemical analogues or degradation products of beta-lactams present in the raw milk sample.

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To guarantee accuracy and maintain strict measurement traceability, GLP standards require that these instruments undergo daily calibration checks using certified, traceable reference weights. This process detects minor environmental or mechanical drifts, ensuring that critical measurements, like sample weight in fat determinations, remain highly accurate and legally defensible.

36. (C) It causes falsely depressed concentration readings
Spectrophotometric analysis determines analyte concentrations by measuring light absorption relative to a reference blank. A blank represents zero analyte concentration. If the blank is contaminated with the target analyte, its baseline absorbance increases. Consequently, when sample absorbance is calculated relative to this high baseline, the resulting measurements will be falsely depressed, yielding inaccurate, low readings.

37. (A) Aseptic inoculation – Laminar air flow cabinet
Conducting microbiological tests under GLP requires specialized equipment to ensure accuracy and prevent contamination. Aseptic inoculation of milk samples onto growth media requires a laminar air flow cabinet, which provides HEPA-filtered, sterile air currents to protect the sample from environmental pathogens. Uncalibrated beakers, high-heat furnaces, or hot air ovens are inappropriate for aseptic inoculation tasks.

38. (D) Organization for Economic Co-operation and Development (OECD)
The foundational principles of Good Laboratory Practice were formally established by the Organization for Economic Co-operation and Development. Developed in the late nineteen-seventies, these international standards were designed to harmonize safety testing protocols, ensure mutual acceptance of non-clinical safety data across member countries, prevent duplicate research, and establish uniform quality systems within scientific testing laboratories.

39. (B) It tracks the sample back to its original supplier, batch, and collection time
Sample traceability is vital under GLP to ensure data integrity and facilitate audits. It establishes an unbroken documented chain of custody from the farm source, specific tanker batch, collection time, and transport conditions, through to laboratory preparation, analysis, and reporting. If a food safety issue occurs, traceability allows rapid identification and targeted recall of the affected batches.

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40. (B) Sampling, transportation under cold chain, aseptic plating, incubation, reporting
Standard GLP protocols dictate a logical sequence for raw milk microbiological evaluations. The process begins with representative sampling, followed by rapid transportation to the laboratory under strict cold chain conditions to suppress bacterial growth. Next, aseptic plating in sterile cabinets prevents environmental contamination. Incubation then allows target colonies to develop before final analytical reporting.

41. (D) It allows analytical data to be reconstructed and audited
Strict documentation and archiving of experimental data represent key requirements in GLP guidelines. They ensure that every step of a laboratory test can be fully reconstructed, verified, and audited by regulatory authorities years after completion. This thorough accountability prevents data manipulation, validates the scientific integrity of safety decisions, and helps trace any post-market quality failures.

42. (A) The metabolic byproduct of Aflatoxin B_1 excreted in milk
Aflatoxin M_1 is a highly toxic hydroxylated metabolite of Aflatoxin B_1. When lactating dairy cattle consume feed contaminated with Aflatoxin B_1, the toxin is absorbed in the gut and transported to the liver. Cytochrome P450 enzymes metabolize the toxin into Aflatoxin M_1, which is subsequently excreted into the milk through the mammary glands.

43. (B) Aspergillus flavus
Aspergillus flavus and Aspergillus parasiticus are filamentous environmental molds that commonly infect agricultural crops and livestock feeds during production or storage. Under warm, humid conditions, these fungi synthesize Aflatoxin B_1 as a secondary metabolite. When dairy cows consume this contaminated grain feed, their livers metabolically convert the precursor toxin into the Aflatoxin M_1 found in milk.

statements two and four are standard correct requirements.

27. (B) Employees with communicable diseases or open lesions must be excluded
Personnel hygiene is a key pillar of Good Manufacturing Practices. Staff carrying communicable diseases or displaying open skin lesions on exposed areas pose a high risk of shedding pathogens, such as Staphylococcus aureus or viral agents, directly into dairy products or processing equipment. Consequently, strict guidelines mandate their immediate exclusion or temporary reassignment away from food-contact tasks.

28. (B) Strategic business pricing of milk
Good Hygiene Practices strictly focus on technical, environmental, and operational conditions necessary for food safety. This incorporates solid waste disposal, wastewater treatment, integrated pest control, and rigorous sanitation of tools. Business pricing strategies, market positioning, and financial structures have no relationship with sanitary control, falling instead under economic management and commercial marketing spheres of dairy processing companies.

29. (A) Integrated pest management
Integrated pest management represents a fundamental GHP prerequisite, designed to prevent, monitor, and eradicate pests in food processing environments. The recurring presence of physical insect fragments in final cheese products indicates a breakdown in this defensive barrier, signaling failure in exclusion measures like insect screens, light traps, sealing entry points, or routine pest monitoring practices.

30. (C) It standardizes quality and minimizes contamination risks
Standardizing Good Manufacturing Practices ensures that dairy operations follow consistent, validated procedures every day. This consistency directly stabilizes the chemical and physical quality of the finished products while systematically reducing microbiological, chemical, and physical contamination risks. It does not eliminate the need for HACCP, but rather establishes a solid prerequisite foundation required for its success.

31. (D) Reviewing chemical concentration logs and conducting regular ATP swab tests
Verification of Clean-In-Place systems requires scientific, quantitative evidence to ensure pathogens and organic matter are eliminated. Monitoring and reviewing operational parameters like chemical concentrations, temperatures, and contact times, combined with Adenosine Triphosphate bioluminescence swab tests of internal surfaces, provide immediate, objective validation of hygienic cleanliness that visual inspections or sensory evaluations cannot match.

32. (C) A quality system for planning, performing, monitoring, and reporting lab studies
Good Laboratory Practices constitute a formal, structural quality system governing the organizational processes and conditions under which laboratory analyses are planned, performed, monitored, recorded, archived, and reported. In dairy quality control, GLP ensures the generation of high-quality, reliable, and reproducible analytical data, which is crucial for verifying compliance with national food safety regulations.

33. (B) I, II and IV
Good Laboratory Practices emphasize absolute traceability and data integrity. SOP availability, precise reagent labeling with expiry dates, and instrument calibration represent core pillars of these standards, validating statements one, two, and four. Raw laboratory data must never be discarded but rather archived securely, and personnel must maintain complete, documented training records to verify their technical competency.

34. (D) Pouring excess chemical reagents back into their original stock containers
In a GLP-compliant environment, chemical integrity is paramount. Pouring excess reagents back into their original stock containers introduces a major risk of cross-contamination, which can compromise the purity of the entire stock and yield inaccurate analytical results. Safe disposal or separate container storage of excess reagents is mandatory to preserve the baseline reliability of all assays.

35. (A) They must be calibrated daily using traceable weights
Analytical balances represent fundamental measuring equipment in dairy laboratories.

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of a veterinary drug to an animal before its milk can be harvested for human food. This duration allows the animal's metabolic and excretory systems to reduce veterinary drug residues to concentrations below legally established safe limits, preventing contaminated milk from entering processing.

54. (C) A is true but R is false.
Antibiotic residues in raw milk present a major economic threat to cheese manufacturers because they inhibit the growth of beneficial lactic acid starter cultures. Without active microbial fermentation, milk cannot develop the necessary acidity, preventing curd formation and ruining the production batch. This demonstrates that while the economic threat is real, the reason statement is biologically false.

55. (B) Beta-lactams
Beta-lactam antibiotics, including penicillin, ampicillin, and cloxacillin, are the most common veterinary treatments utilized to manage bacterial mastitis infections in dairy cattle. Because they are widely administered through intramammary infusions, failure to observe proper withdrawal times frequently leads to beta-lactam residue violations in bulk milk tanks, making them the primary source of pharmaceutical contaminants.

56. (C) Development of resistant bacterial strains and potential allergic reactions
Chronic exposure to low concentrations of antibiotic residues via milk consumption poses a major public health risk. It exerts selective evolutionary pressure on human gut microbiota, promoting the development of multi-drug-resistant bacterial strains. Additionally, sensitive individuals can experience severe hypersensitivity or allergic reactions, such as skin rashes or anaphylaxis, upon ingesting milk containing active drug residues.

57. (D) Administering dry cow therapy to the herd at lactation's end to prevent infection
Prophylactic treatment involves administering medications to healthy animals to prevent potential future infections, rather than treating an active disease. Dry cow therapy, which is the infusion of long-acting antibiotics into the udder of all cows at the end of lactation, serves as a standard prophylactic practice to prevent new infections during the dry period, unlike therapeutic active-infection treatments.

58. (A) It intercepts contaminated tankers to protect starter cultures and health
Testing raw milk for antibiotic residues at the reception dock allows rapid screening before tankers unload. This immediate interception prevents contaminated milk from being co-mingled with large volumes in processing silos. It protects valuable lactic acid starter cultures used in cheese and yogurt making from being inactivated, while safeguarding consumers from exposure to chemical drug residues.

59. (B) Boiling milk completely eliminates tetracycline and sulfonamide residues
Veterinary drug residues like tetracyclines and sulfonamides possess high thermal resistance. Standard milk preparation practices, such as boiling for domestic consumption, do not achieve the high temperatures required to fully degrade these chemical compounds. While boiling may cause minor decreases in drug concentration, it cannot completely eliminate these stable residues, making the assertion of total elimination incorrect.

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60. (B) The milk contains antibiotic residues
Yogurt manufacture depends on lactic acid fermentation by Streptococcus thermophilus and Lactobacillus bulgaricus. These bacteria convert lactose into lactic acid, dropping the pH and coagulating milk proteins. If the raw milk contains active antibiotic residues, particularly beta-lactams, the fermentation process is severely inhibited. The starter cultures are killed or suppressed, resulting in fluid milk that fails to acidify.

61. (A) P-3, Q-1, R-4, S-2
Different antibiotic classes possess distinct clinical properties. Penicillin G is a classic beta-lactam antibiotic associated with severe allergic hypersensitivity in sensitive consumers. Tetracyclines represent broad-spectrum agents that physically bind with calcium ions. The withdrawal period represents the required clearance time for drugs to leave the animal, and chloramphenicol is globally banned due to aplastic anemia risks.

62. (C) Processing contaminated milk into UHT milk to bypass rules
Processing milk with high-heat treatments like ultra-high temperature pasteurization does not degrade or destroy thermostable antibiotic

44. (A) 0.5 μg/kg (ppb)
FSSAI regulations set strict safety thresholds for contaminants in dairy products. For Aflatoxin M_1 in liquid milk, the maximum residue limit is established at zero point five micrograms per kilogram, which corresponds to zero point five parts per billion. This strict threshold aligns with international standards to protect human consumers from chronic toxic liver exposure.

45. (A) It is heat-stable and survives normal pasteurization and UHT
Aflatoxin M_1 possesses high thermal stability due to its chemical ring structure. Standard dairy heat treatments, such as pasteurization, boiling, and ultra-high temperature processing, fail to structurally degrade or inactivate this mycotoxin. Consequently, if raw milk is contaminated, the chemical hazard remains active throughout processing, persisting into retail liquid milk and secondary manufactured dairy products.

46. (C) The liver metabolizes it, excreting Aflatoxin M_1 in milk within 12–24 hours
Ingestion of Aflatoxin B_1 by lactating cows leads to rapid gastrointestinal absorption and transport to the liver. Hepatic microsomal enzymes biotransform the chemical via hydroxylation to form Aflatoxin M_1. This metabolite enters the bloodstream and is actively excreted into milk by the mammary gland, with detectable levels appearing within twelve to twenty-four hours after ingestion.

47. (A) II, IV, I, V, III
The contamination pathway of Aflatoxin M_1 follows a clear biological progression. First, Aspergillus molds grow on improperly stored cattle feed under humid conditions. These molds produce Aflatoxin B_1 within the grain. The cow then ingests this contaminated feed, and its liver metabolizes the toxin into Aflatoxin M_1. Finally, this toxic metabolite is secreted into milk via the mammary glands.

48. (C) Standard processing methods like pasteurization and boiling are ineffective at destroying Aflatoxin M_1.
Chemical stability prevents the destruction of Aflatoxin M_1 during typical dairy manufacturing operations. Standard pasteurization, boiling, autoclaving, or drying processes fail to break down this heat-resistant molecule. Therefore, normal thermal processing cannot be used as a mitigation step to decontaminate milk, meaning control efforts must focus entirely on preventing the initial feed contamination on dairy farms.

49. (B) 1% to 6%
The carry-over rate represents the percentage of ingested Aflatoxin B_1 that is metabolized and excreted as Aflatoxin M_1 in milk. In dairy cattle, this physiological conversion rate typically ranges from one to six percent. This rate can vary based on individual milk yield, lactation stage, liver health, and the total daily volume of contaminated feed consumed by the animal.

50. (D) Group 1 carcinogen primarily affecting the liver
The International Agency for Research on Cancer classifies Aflatoxin M_1 as a Group one human carcinogen. Scientific evidence demonstrates that chronic exposure to this mycotoxin poses a severe risk of hepatotoxicity and is directly linked to the development of hepatocellular carcinoma. Due to these potent mutagenic and carcinogenic properties, regulatory authorities enforce strict limits in dairy products.

51. (A) High humidity caused poor feed storage, promoting Aspergillus growth
Warm temperatures combined with high atmospheric humidity during the late monsoon season create ideal environmental conditions for Aspergillus mold proliferation. If harvested grains and animal feeds are stored improperly under these damp conditions, fungal growth accelerates, leading to high concentrations of Aflatoxin B_1. When cattle consume this feed, it results in elevated Aflatoxin M_1 levels in milk.

52. (C) HPLC with fluorescence detection
High-Performance Liquid Chromatography combined with fluorescence detection represents the standard method for precise quantification of Aflatoxin M_1. Due to the naturally fluorescent chemical structure of aflatoxins, this specialized detection system offers exceptional sensitivity and specificity. This allows laboratory analysts to accurately measure trace contamination levels well below the regulatory limit of zero point five parts per billion.

53. (A) The required time from last drug dose to safe milk collection for humans
The withdrawal period is the mandatory time interval required after the final administration

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72. (C) MilkoTester (infrared milk analyzer for fat/ protein)
Assessing antibiotic residues requires chemical separation or immunological detection methods, which are performed using instruments like HPLC, LC-MS/MS, or ELISA readers. In contrast, a MilkoTester is an infrared spectrophotometer designed to analyze major organic milk constituents, specifically fat and protein percentages, and lacks the analytical capability to detect trace veterinary drug residues.

73. (D) Using rapid lateral flow tests for screening, then saving positives for confirmation
For large-scale dairy reception docks, balancing operational efficiency and food safety is critical. Rapid lateral flow tests serve as the primary screening tool to quickly approve clean tankers within minutes. Any presumptive positive sample is then set aside and verified using highly accurate, quantitative confirmatory techniques like HPLC or LC-MS/MS, optimizing both time and analytical accuracy.

74. (A) The maximum pesticide concentration legally permitted in food
The Maximum Residue Limit is a regulatory threshold representing the highest concentration of a pesticide residue legally permitted in or on food products, including milk and dairy items. Established by food safety authorities based on toxicology data and good agricultural practices, this limit ensures that pesticide exposures remain toxicologically safe for human consumption.

75. (B) I, III and IV
Organochlorine pesticides like DDT and Lindane are characterized by high chemical stability and lipophilicity. This causes them to concentrate in lipid-rich fractions such as milk fat and bioaccumulate up the food chain, validating statements one and three. Because they persist for decades in the environment, statement two is incorrect, leading to global bans as noted in statement four.

76. (B) Because organochlorines persist in soil and resist degradation
Organochlorine compounds like DDT and its stable metabolite DDE possess high chemical resistance to environmental biodegradation, photolysis, and chemical weathering. Consequently, they persist in pasture soils for decades. When dairy cows graze on these lands, they ingest the contaminated soil and grass, transferring these persistent lipophilic chemicals directly into their body tissues and milk fat.

77. (A) They are less persistent and are excreted rapidly, reducing chronic milk contamination
Organophosphate pesticides, such as malathion and chlorpyrifos, possess different physical and chemical properties compared to organochlorines. They are chemically less stable, undergo rapid degradation in the environment, and are metabolized and excreted quickly by dairy cows. This metabolic efficiency prevents long-term bioaccumulation in adipose tissues, significantly reducing the risk of chronic milk contamination.

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78. (C) Organophosphates
Chlorpyrifos, malathion, and parathion are classified chemically as organophosphates. These synthetic chemical compounds contain a central phosphorus atom bonded to oxygen or sulfur. They are widely utilized in agriculture as insecticides due to their ability to inhibit acetylcholinesterase, an essential enzyme regulating nervous system functions in target insect pests and other organisms.

79. (D) Biomagnification
Biomagnification is the process where persistent, lipophilic chemicals like organochlorines increase in concentration at higher levels of the food chain. Plants absorb trace pesticide amounts from soil, herbivores consume vast quantities of these plants, and the fat-soluble compounds accumulate in animal adipose tissues over time, ultimately yielding highly concentrated residues in cow milk fat.

80. (C) The residues concentrate heavily in the butter phase
Organochlorine pesticide residues are highly lipophilic, meaning they dissolve preferentially in lipids rather than water. When whole milk is separated and processed into high-fat dairy products like butter or ghee, these fat-soluble chemical contaminants partition into the fat phase. Consequently, the residues concentrate heavily in finished butter, while the aqueous buttermilk fraction remains mostly free of contaminants.

135. (D) Roese-Gottlieb is a gravimetric reference method using solvent extraction, while Gerber is a volumetric screening method
The Roese-Gottlieb technique serves as an international gravimetric reference standard that relies on ether extraction to isolate lipids from milk. In contrast, the Gerber test is a rapid volumetric method designed for routine laboratory screening and processing control. While Gerber uses acid digestion and centrifugation, Roese-Gottlieb utilizes solvent dissolution to achieve higher precision for scientific calibration.

136. (A) Gravimetry physically measures dry matter directly, avoiding errors from specific gravity or temperature
Gravimetric determination physically isolates and weighs the dry residue after removing water, providing highly accurate measurements of total solids. This direct method remains unaffected by natural variations in specific gravity, physical temperature fluctuations, or milk fat ratios that can distort lactometer readings. It serves as a reliable analytical reference standard despite requiring more time and equipment.

137. (A) The Agricultural Produce (Grading and Marking) Act, 1937
The AGMARK certification system operates under the legal authority of the Agricultural Produce Grading and Marking Act enacted in nineteen thirty-seven. This historic legislation establishes rules for grading, sorting, and marking agricultural commodities to protect consumer interests. It is distinct from safety-focused laws like the Prevention of Food Adulteration Act or general industrial standardization laws.

138. (A) Both A and R are true and R is the correct explanation of A.
The certification symbol on clarified butter packaging provides consumer assurance regarding the product's origin, purity, and grade. This guarantee is backed by comprehensive analytical testing of physical and chemical constants alongside organoleptic evaluations. Evaluating specialized parameters like Reichert-Meissl and Polenske values ensures that the product meets the specific requirements defined for its designated quality classification.

139. (B) Special, General, Standard
The national grading system classifies clarified butter fat into three distinct quality tiers based on chemical parameters and purity levels. These official classifications are designated as Special, General, and Standard grades. Each tier must conform to specified limits for free fatty acids, moisture content, and other chemical markers to qualify for its respective market label.

140. (C) Baudouin test
The Baudouin reaction is a mandatory chemical test used to detect the presence of sesame oil in clarified butter. Sesame oil is legally required to be added to hydrogenated vegetable oil to act as a permanent marker. A positive reaction indicates adulteration with vegetable fat, distinguishing pure dairy fats from cheaper vegetable-based alternatives.

141. (B) 16.0%
Quality regulations restrict the water content in creamery butter to prevent spoilage and maintain product consistency. To achieve certification, the moisture level must not exceed sixteen percent of the total composition. This limit aligns with international dairy standards and ensures proper emulsion stability, flavor retention, and shelf-life during storage and commercial distribution.

142. (C) Because regional agro-climating conditions and cattle feeding practices alter milk fat composition
The composition of volatile fatty acids in milk fat is heavily influenced by the diet of the dairy animals and local environmental conditions. Varied agricultural practices, seasonal changes, and regional vegetation across different states lead to natural fluctuations in the Reichert-Meissl index. The certification framework accounts for these biological variations by establishing region-specific limits.

143. (B) It is administered by the Directorate of Marketing and Inspection under the Ministry of Agriculture
The Directorate of Marketing and Inspection is the government agency responsible for implementing the agricultural grading scheme in India. Operating under the Ministry of Agriculture, this body manages standard formulation, laboratory testing, and the issuance of quality labels. It does not operate under international health organizations or allow private companies to issue certificates independently.

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90. (A) Storing milk in poorly tinned copper or brass vessels with lead solder
Before food-grade stainless steel became standard, milk was frequently processed and stored in copper, brass, or tinned metal containers held together with lead solder. Lactic acid naturally present in milk reacts with these exposed base metals. This chemical reaction causes lead and copper to leach directly into the milk, introducing high levels of toxic heavy metal contaminants.

91. (B) The farm is located near smelting plants, busy highways, or uses sewage fertilizer
Simultaneous contamination of milk with lead and cadmium points to localized environmental pollution. Physical proximity to industrial smelting plants, heavy vehicle traffic burning older fuels, or the agricultural use of untreated sewage sludge as soil fertilizer deposits both heavy metals into the local soil and pasture plants, which dairy cows then ingest during daily grazing.

92. (B) Zinc (Zn)
Zinc is a essential mineral required for numerous enzymatic processes, cell division, and immune functions in humans and cattle. Unlike toxic heavy metals such as lead, cadmium, and arsenic, which offer no biological function and are toxic even at low levels, zinc is classified as an essential dietary micronutrient necessary for maintaining optimal physiological health.

93. (A) Resisting metabolic breakdown, their concentration increases at higher trophic levels
Heavy metals are stable inorganic chemical elements that resist biochemical and metabolic breakdown within biological tissues. Consequently, when animals ingest contaminated water or plants, the metals accumulate in their organs over time. This bioaccumulation compounds at each successive level of the food chain, resulting in significantly higher, toxic heavy metal concentrations at higher trophic levels.

94. (C) ICP-MS
Inductively Coupled Plasma Mass Spectrometry represents the standard technique for analyzing trace heavy metals. This method couples high-temperature argon plasma, which atomizes and ionizes the milk sample, with a sensitive mass spectrometer. ICP-MS offers exceptional sensitivity, extremely low detection limits, and the unique ability to measure multiple elements simultaneously at parts-per-billion levels.

95. (D) To consolidate older food laws and establish FSSAI for science-based standards
The Food Safety and Standards Act of 2006 was enacted to consolidate multiple fragmented food-related laws, such as the Prevention of Food Adulteration Act and the Milk Order. By establishing the Food Safety and Standards Authority of India, it created a single, unified regulatory framework to set science-based safety standards for food manufacture, storage, and distribution.

96. (A) II, IV, I, III
Obtaining an FSSAI Central License follows a structured administrative sequence. First, the dairy operator submits the application using Form-B via the FoSCoS portal. Next, the Designated Officer scrutinizes the application and documents for completeness. Once approved, the FSSAI authority conducts a physical inspection of the premises, culminating in the issuance of the fourteen-digit license.

97. (B) Ministry of Health and Family Welfare
The Food Safety and Standards Authority of India is a statutory regulatory body established under the FSS Act of 2006. Because its primary mandate is to protect and promote public health through the regulation and supervision of food safety, it operates under the administrative control of the Union Ministry of Health and Family Welfare of the Government of India.

98. (D) General hygienic and sanitary practices for food business operators (GMP/GHP)
Schedule 4 of the FSSAI Licensing and Registration regulations provides the mandatory legal blueprint for sanitary and hygienic practices. It details the structural, operational, and personnel requirements that food business operators must implement as part of Good Manufacturing Practices and Good Hygiene Practices. Compliance with Schedule 4 is a critical prerequisite for obtaining and maintaining any FSSAI license.

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99. (A) The FSSAI License Number must be displayed prominently at the business premises and printed on all applicable food packages
The FSSAI License Number must be displayed prominently at the business premises and printed on all applicable food packages because the Food Safety and Standards regulations require licensed Food Business Operators to ensure traceability, transparency, and regulatory compliance. This helps consumers identify licensed businesses and enables effective enforcement. The other options are incorrect because the license number is mandatory for applicable products and is neither confidential nor optional.

100. (C) Central FSSAI Licenses for their units and head office
FSSAI licensing thresholds are based on production volume and geographical operations. Dairy processing units handling more than fifty thousand liters of liquid milk per day are categorized under Central licensing. Furthermore, because this cooperative operates across multiple states, its individual processing facilities and its corporate head office must secure Central FSSAI Licenses to legally operate under national regulations.

101. (A) Form D1 – Annual Return for dairy manufacturing units
FSSAI compliance requires food business operators to submit periodic documentation. Form D1 is the legally mandated annual return form that all food manufacturers, including dairy processing and packaging units, must file on or before the thirty-first of May each year. This return reports the quantities, sources, and sales volumes of milk and dairy products handled.

102. (D) They face penalties, fines, and potential imprisonment under the Act
Operating any commercial food business, including dairy processing, without a valid FSSAI registration or license violates the FSS Act of 2006. Regulatory authorities enforce strict penalties to protect public health. Violators face substantial financial fines, immediate closure of the processing unit, seizure of products, and potential imprisonment, depending on the severity and scale of the non-compliant operation.

103. (C) A is true but R is false.
FSSAI regulations mandate a State License for dairy units processing between ten thousand and fifty thousand liters of milk per day within a single state. This makes the assertion true. However, the reason is false because Central Licenses are also required for large-scale domestic units over fifty thousand liters capacity, irrespective of whether they engage in international trade.

104. (C) It created a "single-window" system to regulate food businesses
Before 2006, food businesses in India had to comply with multiple overlapping laws administered by different ministries, causing regulatory confusion. The enactment of the unified FSS Act consolidated these legacy orders into a single, comprehensive statute. This legislative consolidation established a streamlined, single-window licensing and registration system under FSSAI, simplifying compliance for food business operators nationwide.

105. (D) Essential Commodities Act, 1955
The FSS Act of 2006 repealed and integrated older safety-specific food regulations, including the Prevention of Food Adulteration Act and the Milk and Milk Products Order. However, the Essential Commodities Act of 1955 remained separate. This act regulates the supply, pricing, and distribution of essential goods to prevent hoarding, and is not a safety-specific food standards regulation.

106. (B) Fat 3.0%, SNF 8.5%
FSSAI regulations define standard compositional requirements for various liquid milk classes. For toned milk, which is prepared by blending whole milk with skim milk or water and skim milk powder, the minimum legal standards are established at three point zero percent milk fat and eight point five percent solids-not-fat across all states and union territories of India.

107. (C) 4.5%
Standardized milk is adjusted by dairy processors to possess a uniform, reliable nutritional profile. Under FSSAI standards, the minimum fat requirement for standardized milk is set at four point five percent throughout India, while the solids-not-fat parameter must be maintained at a minimum of eight point five percent, ensuring nutritional quality for retail milk consumers.

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108. (B) Adding any food additive, preservative, or color is strictly prohibited
FSSAI regulations enforce high standards to preserve the natural purity of liquid milk. Under these rules, adding any type of synthetic preservative, artificial coloring agent, thickener, stabilizer, or chemical neutralizer to plain, pasteurized liquid milk is strictly prohibited. Plain milk must remain a completely natural food product, free from any non-milk additives.

109. (A) Double Toned Milk
Under FSSAI definitions, adjusting milk composition by extracting fat or blending it with skim milk to achieve a lower fat content yields toned milk varieties. A final product possessing exactly one point five percent milk fat and a minimum of nine point zero percent solids-not-fat is legally classified as double toned milk, contrasting with standard toned milk.

110. (C) P-2, Q-4, R-1, S-3
Liquid milk classes must meet specific chemical standards. Full cream milk requires at least six percent fat and nine percent solids-not-fat. Double toned milk is standardized to one point five percent fat and nine percent solids-not-fat. Skimmed milk contains a maximum of zero point five percent fat, whereas cow milk has a minimum of four percent fat.

111. (D) Nisin is a permitted bio-preservative, while raw milk addition of H_2O_2 is adulteration
FSSAI regulations distinguish legal additives from prohibited adulterants. Nisin is an approved biological peptide preservative that can be added to specific dairy products, like processed cheese, to prevent spoilage. Hydrogen peroxide, however, is a strong chemical oxidizer whose direct addition to raw milk is classified as illegal chemical adulteration, used to mask sourness or poor hygiene.

112. (C) Product made by mixing butter oil, skim milk powder, and water to meet fat/SNF standards
Under FSSAI terminology, recombined milk is defined as a standardized liquid milk product manufactured by combining anhydrous milk fat or butter oil, skim milk powder, and potable water. These ingredients are precisely blended and homogenized to rebuild milk structure and achieve the legally required fat and solids-not-fat percentages, making it distinct from reconstituted skim milk.

113. (B) Plain pasteurized whole milk – Natamycin preservative
FSSAI regulations maintain that plain pasteurized whole milk must be completely free of chemical preservatives, coloring agents, or stabilizers. Natamycin is an approved antifungal preservative, but its legal use is strictly restricted to surface treatments of specific cheeses to prevent mold growth, making its pairing with plain pasteurized whole milk highly incorrect.

114. (D) BHA or Tocopherols
Oxidative rancidity occurs when unsaturated milk lipids react with oxygen, forming aldehydes and ketones that cause off-flavors. To prevent this deterioration in fat-rich dairy products, antioxidant additives like Butylated Hydroxyanisole or natural tocopherols are permitted under FSSAI standards. These compounds chemically neutralize free radicals, thereby successfully extending the shelf life and preserving product quality.

115. (A) Extraction of fat to produce skim milk
Adulteration involves adding unauthorized substances or extracting vital nutrients illegally to deceive consumers. Centrifugal separation to extract fat is a standard, legal

116. (B) 1986
The Bureau of Indian Standards was established under the Bureau of Indian Standards Act of 1986. This landmark legislative enactment replaced the older Indian Standards Institution Certification Marks Act of 1952. The transition marked the modernization of national standardization efforts in India, empowering the newly formed bureau to handle product certification and quality marking systematically.

117. (C) I and II only
Indian regulatory frameworks mandate compulsory certification for highly concentrated and processed dairy items to ensure food safety and consumer health. Condensed milk and milk powder products require the Bureau of Indian Standards certification mark before commercial sale. Fresh pasteurized liquid milk in pouches is regulated primarily through standard food safety licensing channels rather than mandatory certification schemes.

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81. (B) Ingestion of contaminated fodder or water runoff by cattle
Herbicides are widely applied to agricultural crops and pastures to control weeds. The primary entry pathway of these chemical compounds into the dairy supply chain occurs when cows consume fodder treated with herbicides, or drink agricultural water runoff from nearby fields. Once ingested, these chemical compounds can pass through the animal's digestive system and enter the milk.

82. (A) I, II and IV
Preventing pesticide residues in milk requires rigorous agricultural controls and monitoring. sourcing clean feed, routine gas chromatography testing, and observing dermal application withholding periods are highly effective mitigation strategies, validating statements one, two, and four. Dermal chemical washes before milking introduce contamination, and boiling cannot evaporate these highly stable molecules, making statements three and five incorrect.

83. (A) Thermal pasteurization
Pesticides, especially organochlorine compounds, possess high chemical and thermal stability, enabling them to easily survive dairy processing heats. Thermal pasteurization, which is designed to eliminate pathogenic microorganisms, is completely ineffective at breaking down or reducing these chemical residues. Suggesting pasteurization as a method to mitigate pesticide contamination is chemically incorrect, requiring control at the farm source instead.

84. (C) Industrial emissions, vehicle exhaust, and soil ingestion by cattle
Lead enters the dairy food chain mainly through environmental pathways. Industrial emissions and exhaust from vehicles burning leaded fuels deposit lead particles onto pasture soils and forage crops. When dairy cows graze, they ingest these contaminated plants and direct soil particles. This heavy metal is then absorbed in the animal's digestive tract and excreted into the milk.

85. (A) The kidneys and the skeletal system
Cadmium is a highly toxic heavy metal with a long biological half-life in humans. Chronic dietary exposure to cadmium, such as through contaminated dairy products, leads to bioaccumulation primarily in the renal cortex, causing severe kidney damage. This renal dysfunction impairs calcium metabolism, which subsequently leads to bone demineralization, osteoporosis, and skeletal system disorders.

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86. (D) Mercury levels in cow's milk are naturally very high, typically exceeding 500 mg/kg
Mercury is an environmental pollutant that enters the dairy supply chain through water and industrial effluents, bioaccumulating in animals as toxic methylmercury, which poses severe neurotoxic risks. However, natural mercury levels in clean cow's milk are extremely low, typically appearing in trace microgram quantities rather than high levels exceeding five hundred milligrams, making that statement false.

87. (B) Through drinking water and fodder crops drawn from contaminated groundwater
In endemic regions, groundwater aquifers naturally contain high concentrations of inorganic arsenic. When this water is pumped up for dairy cows to drink, or used to irrigate cattle fodder crops like paddy straw, arsenic bioaccumulates in the plants. Ingesting this contaminated water and agricultural fodder represents the primary pathway for arsenic to enter the cattle's system.

88. (C) Methylmercury is highly bioavailable, bioaccumulative, and highly neurotoxic
Methylmercury is an organic form of mercury produced by environmental bacteria. Unlike inorganic or elemental mercury, methylmercury is highly lipophilic and bioavailable. This property allows it to be easily absorbed in the animal gastrointestinal tract, cross the blood-brain barrier, bioaccumulate through successive trophic levels, and exert severe, permanent neurotoxic damage on developing central nervous systems.

89. (C) Sample collection → Sample digestion (ashing to destroy organic matter) → Reconstitution/ Dilution → Aspiration and Absorption measurement
Analyzing heavy metals in milk via atomic absorption spectroscopy follows a precise chemical preparation protocol. The process begins with sample collection, followed by thermal or wet acid digestion ashing to completely destroy the organic milk matrix. The remaining inorganic mineral residue is then reconstituted in dilute acid, and aspirated into the spectrometer flame or furnace for absorption measurements.

126. (C) A portion representing the exact chemical and physical composition of the entire bulk volume
A representative sample must accurately reflect the uniform characteristics of the entire batch from which it is drawn. Achieving this requires proper agitation of the bulk volume to eliminate stratification of fat and other constituents before extraction. Samples taken without adequate mixing do not provide a reliable basis for chemical analysis and quality control decision-making processes.

127. (B) Gerber method
The Gerber technique is the recognized volumetric standard method for determining fat content in various liquid dairy products within Indian laboratories. This chemical process relies on digesting milk proteins with sulfuric acid and separating the liberated fat using amyl alcohol and centrifugation. It offers a rapid, reliable, and standardized approach for routine quality control testing in processing facilities.

128. (D) Standardized methods of rapid, chemical, and bacteriological testing for dairy products
Indian Standard fourteen seventy-nine provides comprehensive guidelines detailing chemical and bacteriological testing methodologies for liquid milk. These protocols establish uniform laboratory procedures for assessing milk quality, freshness, and safety across the country. The standard focuses entirely on analytical science, excluding non-technical aspects like facility design, livestock breeding, and economic pricing structures for raw milk procurement.

129. (A) Composite sampling
Preparing a single representative sample from multiple daily increments allows laboratories to evaluate average composition over a specific period efficiently. This composite approach reduces analytical workload while maintaining accuracy for payment or tracking purposes. It differs from single grab samples, which only provide a localized snapshot, and aseptic sampling, which focuses on preventing microbial contamination during collection.

130. (C) Gravimetric drying in hot air oven – Total solids content
Determining total solids content involves evaporating all moisture from a known weight of milk using a temperature-controlled hot air oven. The remaining dry matter is measured gravimetrically to calculate the percentage concentration. Other analytical pairings like Kjeldahl measure nitrogenous compounds for protein calculation, while the Gerber test measures fat volume rather than total protein content.

131. (B) III and IV
Regulatory guidelines prohibit exposing milk samples to direct sunlight, which can induce lipid oxidation and degrade key components. Chemical preservatives must never be added to portions intended for sensory evaluation, as they alter taste and aroma profile. Proper sampling requires thorough agitation, sanitized equipment, and sterilized containers to ensure physical, chemical, and microbiological integrity of the specimen.

132. (C) 10.75 ml
The standard volumetric pipette used in the Gerber fat test is calibrated to deliver exactly ten point seven five milliliters of milk. This specific volume ensures that the mass of milk delivered corresponds precisely to eleven grams of milk based on average specific gravity. This precise volumetric measurement is critical for obtaining accurate fat percentage readings on the butyrometer scale.

133. (B) Stratification of fat (creaming) occurs, causing inaccurate, non-representative fat readings
Milk fat naturally rises to the surface over time due to differences in specific gravity, creating distinct concentration layers. Failing to agitate the bulk tank thoroughly before extraction leads to sampling either highly concentrated cream or depleted skimmed milk layers. The resulting laboratory analysis will provide inaccurate fat readings that do not represent the actual bulk composition.

134. (A) Sulfuric acid and amyl alcohol
The Gerber fat determination method utilizes a specific combination of concentrated sulfuric acid and amyl alcohol. The strong acid digests the protective protein membrane surrounding fat globules, generating heat that liquefies the lipids. Adding amyl alcohol reduces interfacial tension, which facilitates the clean separation and collection of the fat column during subsequent centrifugation steps.

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are eliminated from the final product. They are distinct from physical objects, chemical residues, or allergenic substances that may contaminate food streams.

154. (B) Verification strictly involves redesigning the processing equipment from scratch annually
Verification involves routine activities that confirm the safety plan is being followed correctly on a daily basis. This process includes reviewing monitoring records, auditing operations, and calibrating instruments rather than redesigning processing equipment from scratch. In contrast, validation provides scientific evidence that the established control measures are capable of effectively controlling the identified hazards.

155. (A) Divert the sub-standard milk using a flow diversion valve and apply corrective actions
When monitoring systems detect that pasteurization temperatures have fallen below the established critical limit, immediate action is required to prevent contaminated product from advancing. The system must automatically engage a flow diversion valve to redirect the under-processed milk back to the balance tank. Operators must then implement documented corrective actions to resolve the thermal deviation.

156. (C) Establish a multi-million dollar marketing budget
The structured food safety framework focuses entirely on technical, scientific, and operational protocols to prevent contamination in food manufacturing. Commercial aspects such as corporate advertising budgets, sales promotions, and marketing plans are completely excluded from the seven core principles. The system prioritizes physical hazard prevention, chemical residue control, and biological pathogen elimination above business profitability metrics.

157. (D) Shifting from reactive, end-product testing to a proactive, preventive process-control model
Traditional quality control systems rely on testing finished products to detect defects after manufacturing is complete, which can be inefficient. The preventive safety framework shifts focus to controlling the manufacturing process itself to stop hazards from occurring. This proactive approach ensures that safety is built directly into every production step, reducing waste and consumer risk.

158. (C) A scientific criterion separating acceptable from unacceptable hazard control limits at a CCP
A critical limit is a scientifically validated boundary that distinguishes safe operating conditions from unsafe ones at a specific process step. This criterion must be measurable in real-time, allowing operators to determine immediately if a process remains under control. It does not relate to physical vehicle capacities, facility boundary lines, or employee staffing levels.

159. (B) P-3, Q-4, R-1, S-2
Process steps in a dairy plant target specific hazards to ensure product safety. Raw milk reception screening detects veterinary drug residues, while physical filtration removes dirt and debris. High-temperature short-time pasteurization destroys vegetative bacterial pathogens, and final packaging metal detection prevents metal fragments from reaching the consumer in the finished product.

160. (B) The CCP Decision Tree, using a logical sequence of questions at each process step
The decision tree is a structured logical tool consisting of a series of questions applied to each step in the manufacturing process. This systematic guide helps safety teams objectively determine whether a specific stage is a critical control point. It replaces subjective opinions, financial projections, or consumer preference surveys during safety plan development.

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161. (D) Because it is a step where control is applied to eliminate or reduce pathogens to safe levels
Thermal pasteurization is designated as a critical control point because it is the primary step specifically designed to destroy vegetative pathogens. Failing to control this thermal process represents a direct hazard to public health, as subsequent processing steps do not eliminate microbial survival. Precise monitoring of temperature and time at this stage guarantees microbial safety.

162. (A) Continuous automated recording of pasteurization temperature and holding flow rates
Monitoring a thermal pasteurization system requires continuous, real-time measurements to verify that all milk receives adequate heat treatment. Automated sensors must constantly

144. (D) Butyro-Refractometer (BR) reading at 40°C
Measuring the refraction of light through liquid fat provides a physical constant known as the Butyro-Refractometer reading. This assessment is conducted at a standardized temperature of forty degrees Celsius to evaluate fat purity. Unlike chemical parameters like saponification or free fatty acid levels, this index relies purely on optical properties to detect potential adulteration.

145. (A) P-2, Q-1, R-4, S-3
The grading framework utilizes distinctive color-coded labels to help consumers identify the quality tier of certified products in the market. Special grade items carry a red label, while general grade products display a green identifier. Standard grade is marked with a chocolate or brown label, whereas unclassified products do not receive any official certification labeling.

146. (C) Synthetic non-dairy coffee creamer
The agricultural grading system focuses on certifying natural agricultural commodities, livestock products, and traditional dairy fats like ghee and butter. Synthetic non-dairy products do not originate from agricultural raw materials and are excluded from this framework. These processed chemical formulations are regulated by general food safety licensing bodies rather than agricultural quality grading schemes.

147. (A) Adulteration with fats containing high levels of insoluble volatile fatty acids
A reduced Reichert-Meissl value combined with an elevated Polenske value indicates a shift in the ratio of soluble to insoluble volatile fatty acids. This chemical imbalance suggests that the milk fat has been adulterated with oils rich in lauric and myristic acids, such as coconut or palm kernel oil. These vegetable fats distort standard volatile acid profiles.

148. (D) Pillsbury Company, NASA, and the United States Army Research Laboratories
The hazard analysis system was developed during the nineteen sixties through a collaborative effort to ensure absolute food safety for astronauts. The Pillsbury Company worked alongside the National Aeronautics and Space Administration and military research laboratories to design this preventive protocol. Their objective was to eliminate the risk of foodborne illnesses during manned spaceflight missions.

149. (B) 7
The international food standards body defines seven fundamental principles that constitute the hazard analysis and critical control point framework. These steps guide food safety teams through identifying hazards, determining critical control points, establishing limits, monitoring procedures, corrective actions, verification, and record-keeping. Adhering to all seven steps is necessary to build an effective preventive food safety system.

150. (B) Principle 3 – Establish Critical Limits
Establishing critical limits is the third principle of the hazard analysis framework, defining the boundaries that separate safe food processing from unsafe conditions. Other principles include conducting hazard analysis as the first step and establishing corrective actions as the fifth step. Each principle must be executed in its correct logical order to ensure system integrity.

151. (D) They establish the essential hygienic and operational foundation needed for the HACCP plan
Prerequisite programs provide the environmental and operational conditions necessary for producing safe food throughout the manufacturing facility. These programs manage general hazards, allowing the specialized hazard analysis plan to focus exclusively on critical process steps. Without robust sanitation and manufacturing practices in place, a critical control point strategy cannot function effectively or maintain process control.

152. (A) Both A and R are true and R is the correct explanation of A.
Process steps containing potential hazards are not automatically classified as critical control points if subsequent stages can manage the risk. A step is designated as a critical control point only when control is absolutely necessary to prevent, eliminate, or reduce the hazard to acceptable levels. This logical selection prevents overwhelming the monitoring system with unnecessary parameters.

153. (B) As a biological hazard
Pathogenic microorganisms capable of causing foodborne illness are classified as biological hazards within the safety assessment framework. These living entities require targeted thermal processes, such as pasteurization, to ensure they

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118. (C) The relevant Indian Standard (IS) specifications for quality and safety
The presence of the Indian Standards Institution mark indicates that a product complies with specific domestic technical parameters. These benchmarks are formulated to cover safety, quality, and compositional requirements for food items. This quality assurance scheme operates independently of product pricing, aesthetic packaging design choices, or international standards that are not formally adopted by the regulatory body.

119. (D) FSSAI enforces baseline food safety compliance, whereas BIS certifies adherence to elevated quality standards
Food Safety and Standards Authority licensing focuses on preventing adulteration and ensuring minimum health safety standards across all food business operators. Conversely, Bureau of Indian Standards certification evaluates conformity with higher, specific quality standards and manufacturing protocols. This distinction separates basic legal market entry requirements from voluntary or mandatory quality assurance certifications that guarantee superior product attributes.

120. (A) The ISI mark can be self-applied by any dairy manufacturer without formal BIS approval
Application of the certified quality mark is strictly restricted to manufacturing units that have received formal authorization from the national standards body. Self-certification without independent assessment, verification of testing infrastructure, and regulatory approval is illegal. Authorized facilities must maintain fully functional testing laboratories, submit to regular surveillance audits, and periodically renew their licenses to verify ongoing compliance.

121. (D) IS 13688
Indian Standard thirteen thousand six hundred eighty-eight defines the chemical, physical, and microbiological specifications for pasteurized liquid milk. This specific document details the essential quality requirements, processing parameters, and hygiene standards that processors must satisfy. Other standards cover different dairy products, ensuring that liquid milk has its own dedicated regulatory framework within the national system.

122. (B) The BIS license may be suspended or cancelled, and product recall initiated
Non-compliance with physical or chemical parameters during routine market surveillance triggers strict regulatory penalties to protect consumers from substandard products. The standards body holds authority to suspend or cancel the manufacturing license of the non-compliant unit. Additionally, the manufacturer must initiate immediate product recalls for the defective batches to prevent further distribution and sale.

123. (A) The product must satisfy both the legal FSSAI requirements and the BIS standard specifications
Food processors must operate in accordance with both mandatory safety regulations and product quality standards. When minor variations exist between safety limits and quality specifications, manufacturers must formulate their products to satisfy both sets of criteria simultaneously. Adhering to the more stringent parameter ensures complete compliance with national safety laws and specialized quality certification frameworks.

124. (A) I, II and III
Maintaining a valid quality license requires strict adherence to continuous analytical testing protocols and systematic record management. Dairy plants must consistently execute the designated testing scheme, document periodic calibration of analytical instruments, and correctly display certification details on packaging. Automated operations are not a mandatory prerequisite for holding or sustaining these quality certifications within processing facilities.

125. (D) To monitor continuous compliance with quality standards after the initial license is issued
Surveillance audits serve as a critical post-certification mechanism to verify that dairy manufacturing facilities maintain the required standards over time. These evaluations ensure that initial quality levels do not degrade after the license is granted. They focus purely on technical compliance and quality systems rather than regulating commercial pricing, creating promotional brand logos, or managing farm-level livestock.

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record the temperature of the milk at the end of the holding tube and track pump flow rates. This immediate feedback ensures deviations are detected instantly, unlike retrospective laboratory testing methods.

163. (C) Isolate the package, test the detector calibration, investigate the source, and handle the product safely
When an inline metal detector rejects a product package, the facility must isolate the affected item to prevent shipping. Operators must verify that the detection instrument is calibrated correctly and investigate the potential source of contamination. The rejected product must be evaluated and handled according to documented safety protocols before resuming normal operations.

164. (A) A Critical Control Point (CCP) to control physical hazards
Passing packaged products through an inline metal detector serves as a critical control point focused on physical contamination. This final screening step is designed to detect and reject any ferrous or non-ferrous fragments introduced by processing machinery. Because it represents the last opportunity to catch physical hazards, it must be monitored with high precision.

165. (D) It is a control measure, often classified as a CCP or PRP, focused on minimizing hazard growth
Rapid cooling of raw milk to low temperatures acts as a critical control measure to inhibit the growth of spoilage and pathogenic bacteria. While refrigeration does not destroy existing microorganisms, it prevents their rapid multiplication during storage and transport. This temperature management is classified as a prerequisite program or critical control point to preserve quality.

166. (B) It provides documented proof of process control and due diligence during safety audits
Maintaining detailed logs of critical control parameters provides verifiable evidence that the manufacturing processes have remained under control over time. These documents serve as legal proof of due diligence and regulatory compliance during internal and external food safety audits. They facilitate product traceability and help identify the root causes of any quality deviations.

167. (C) Significant hazards linked to undocumented steps may be completely overlooked in the hazard analysis
An accurate process flow diagram is essential for conducting a comprehensive hazards assessment across the manufacturing line. If steps are omitted or incorrectly represented, the safety team may fail to evaluate potential physical, chemical, or biological risks associated with those stages. This gap can lead to unsafe products reaching the commercial market undetected.

168. (D) A multidisciplinary team of quality, production, engineering, and maintenance experts
Designing an effective food safety plan requires diverse expertise across different operational areas of the manufacturing facility. A multidisciplinary team consisting of production managers, quality control chemists, mechanical engineers, and sanitation specialists should collaborate to develop the protocols. This collaborative approach ensures that all aspects of the process are thoroughly evaluated and controlled.

169. (A) Quality Management System
The abbreviation refers to a formalized quality management system that documents processes, procedures, and responsibilities for achieving quality policies and objectives. This structured framework helps organizations coordinate and direct their activities to meet customer and regulatory requirements consistently. It serves as a foundation for continuous improvement and operational efficiency across various industries worldwide.

170. (D) ISO 9001:2015
The most current iteration of the international quality standard was published in the year twenty fifteen. This updated version introduced a high-level structure common to all management standards and placed greater emphasis on risk-based thinking. It replaced the previous version from twenty eight, aligning quality management systems with modern global business practices and organizational needs.

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171. (A) Plan-Do-Check-Act (PDCA) cycle
The international quality standard utilizes the plan, do, check, act cycle as its primary operational framework. This iterative four-step management method is designed to drive continuous process improvement and organizational learning. By

189. (D) Validation of the process, ensuring scientific proof of effective hazard control
Introducing a novel preservation technique requires collecting scientific evidence to prove that the process consistently controls target hazards. This validation step must occur before implementation to demonstrate that the new technology is as effective as traditional thermal methods. It ensures that safety claims are backed by rigorous scientific data rather than assumptions.

190. (C) A disciplined, data-driven method using statistical tools to reduce defects and process variation
Six Sigma is a structured methodology designed to improve process performance by identifying and eliminating the root causes of errors. It relies on advanced statistical analysis to minimize variability in manufacturing and business processes. By standardizing operations, organizations can consistently deliver high-quality products that meet precise customer specifications and regulatory standards.

191. (A) 3.4 DPMO
Operating at a Six Sigma quality level represents near-perfection in manufacturing and service delivery processes. Statistically, this performance level permits a maximum of three point four defects per million opportunities. Achieving this extremely low error rate requires highly controlled processes with minimal variation, resulting in high product consistency and reduced waste.

192. (D) Define, Measure, Analyze, Improve, Control
The standard improvement methodology for existing processes is structured into five sequential phases. These stages require project teams to define the problem, measure current performance, analyze the root causes of variation, improve the process by implementing solutions, and control the process to sustain the gains. Each phase must be completed systematically to ensure success.

193. (A) Analyze – Implementing the final solution and closing the project
The analytical phase of the improvement cycle focuses on identifying and verifying the root causes of process defects using statistical tools. Implementing solutions and standardizing the process occur during the subsequent improvement and control phases. Misaligning these stages can lead to deploying solutions before the actual source of the problem is understood.

194. (C) When an existing process is fundamentally broken, or when designing a new process from scratch
Project teams utilize the design for Six Sigma framework when they need to develop a completely new process or product. It is also selected when an existing process has been optimized but still fails to meet quality standards, requiring a total redesign. This differs from the standard cycle, which focuses on improving existing operations.

195. (D) Black Belt
Certified individuals who lead complex quality improvement projects full-time are designated as Black Belts within the organizational hierarchy. These specialists possess advanced skills in statistical analysis, project management, and leadership. They act as mentors to green and yellow belts while working closely with project champions to drive significant operational improvements.

196. (D) Less variation reduces defect rates, waste, and material giveaway while boosting satisfaction
Minimizing process variation ensures that every product manufactured conforms closely to the target specifications. In dairy packaging, this consistency prevents overfilling pouches, which reduces material waste, and underfilling, which violates consumer protection laws. Standardizing output quality directly lowers operational costs, improves yield, and increases overall customer trust in the brand.

197. (B) Verify
The design methodology concludes with a verification phase rather than a standard control phase. This final stage involves testing and verifying that the newly designed process performs as intended and meets all customer requirements under real-world conditions. It ensures the design is validated before transitioning the process to standard daily operations.

198. (B) Measure
Before analyzing process performance, project teams must verify that their measurement systems are producing reliable data. During the measurement phase, tools like Gage Repeatability and Reproducibility are used to assess the variation introduced by operators

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for organizations throughout the food supply chain to demonstrate their ability to control safety hazards. It focuses entirely on preventing contamination and ensuring that food is safe for human consumption.

181. (B) Standard HACCP principles and prerequisite programs integrated with the ISO 9001 QMS structure
The food safety standard achieves global efficacy by combining the preventative hazard analysis framework with structured quality management system elements. It embeds the codex hazard analysis principles and prerequisite programs within a process-based management model. This integration ensures that food safety is managed with the same rigorous continuous improvement focus as general corporate quality systems.

182. (C) Interactive communication across internal and external stakeholders both upstream and downstream
Effective management of safety hazards requires structured information sharing across all tiers of the supply chain. The standard mandates interactive communication with suppliers, customers, and regulatory authorities to ensure potential risks are identified and controlled. This open exchange of safety data prevents information gaps that could lead to contamination incidents in finished products.

183. (D) CCPs have strict measurable critical limits, while OPRPs utilize action criteria without real-time limits
Critical control points require strict, measurable critical limits that can be monitored in real-time to separate acceptable states from unacceptable ones. In contrast, operational prerequisite programs manage specific hazards through defined action criteria rather than continuous numerical limits. While both are essential for control, they differ in their measurement complexity and monitoring methods.

184. (A) ISO 9001 focuses on general quality and satisfaction, whereas ISO 22000 manages food safety hazards
The primary distinction between these two standards lies in their core objectives and scope of application. One standard is a general framework focused on process quality, customer satisfaction, and business efficiency. The other is a specialized safety framework designed exclusively to identify, prevent, and control biological, chemical, and physical food safety hazards.

185. (B) ISO/TS 22002 technical specification series
Implementing robust prerequisite programs in food processing requires detailed guidance beyond the general requirements of the main safety standard. The technical specification series twenty-two thousand two provides sector-specific requirements for sanitary design, pest control, and personnel hygiene. Dairy processors utilize these detailed technical documents to build a compliant and hygienic operational foundation.

186. (B) The plant must update the FSMS, reassess the hazards, and modify relevant control measures
Discovering a new biological hazard requires immediate review of the existing food safety management system. The quality team must conduct a updated risk assessment and modify processing parameters or control measures to neutralize the threat. Ignoring the new data or continuing with outdated protocols violates safety standards and compromises public health safety.

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187. (A) To ensure the plant can manage unforeseen emergencies without compromising finished food safety
Developing emergency protocols ensures that manufacturing facilities can respond effectively to unexpected crises, such as utility failures or natural disasters. These structured plans focus on maintaining product safety during operational disruptions, preventing compromised items from reaching the market. The objective is to protect consumer health rather than managing corporate financial parameters during crises.

188. (C) A mandatory minimum profit target for the fiscal year
A food safety management system is structured around prerequisite programs, hazard analysis, critical control points, system management, and interactive communication. It focuses entirely on technical and operational measures designed to guarantee product safety. Commercial financial targets, profit margins, and sales goals are business management parameters that lie outside the scope of food safety standards.

226. (C) Mandatory unannounced surprise audits integrated into the certification cycle
Integrating unannounced audits into the evaluation cycle ensures that food processing plants maintain high hygiene and safety standards every day. This mechanism prevents facilities from temporarily preparing only for scheduled assessments, reflecting actual operational conditions. It reinforces continuous compliance, building buyer and regulatory confidence in the validity of the certification.

227. (A) It eases global market access by satisfying retail safety rules and avoiding multiple audits
Achieving a globally recognized certification provides food exporters with immediate access to international retail markets. Because major global retailers accept these benchmarked standards, certified manufacturers can avoid undergoing multiple redundant audits from different buyers. This recognition streamlines logistics, reduces administrative costs, and verifies compliance with safety requirements.

228. (D) ISO 22000 lacks the specific prerequisite requirements needed for GFSI benchmarking status
The primary reason global buyers prefer the comprehensive scheme over the base standard is the inclusion of detailed prerequisite programs. The standalone standard lacks the specific technical specifications required to achieve benchmarking status under the global initiative. The integrated scheme addresses these gaps, providing a complete food safety package.

229. (B) Basic local city health department GMPs
While global retail food safety schemes are benchmarked to ensure equivalent standards, local city health department guidelines are not. These local municipal inspections focus on basic sanitation and licensing within a specific jurisdiction rather than meeting international benchmarking criteria. They do not carry global recognition or satisfy the requirements of international buyers.

230. (C) Retailer-driven supply chain safety rules enforcing global standards beyond basic regulations
Supermarket chains that require suppliers to hold specific food safety certifications demonstrate how private sector requirements shape global quality standards. These retail mandates often exceed basic national regulatory requirements, pushing agricultural and food producers to adopt advanced safety practices. This commercial enforcement mechanism drives widespread compliance with international safety standards.

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and testing equipment. Ensuring measurement integrity is critical before drawing conclusions from collected data.

199. (D) The AGMARK grading certificate
Statistical process improvement projects rely on analytical tools like fishbone diagrams, pareto charts, and control charts to identify and resolve defects. An agricultural grading certificate is a regulatory compliance label rather than an analytical tool used to measure process variation. It does not provide statistical data for process analysis.

200. (A) It lets operators monitor processes in real-time and fix issues before defects occur
Statistical process control charts provide operators with real-time visual data on process performance. By tracking trends and identifying non-random variations, team members can take corrective action before parameters exceed acceptable limits and produce defective products. This proactive monitoring sustains the improvements achieved during the project.

201. (B) An organization-wide philosophy centered on continuous improvement and total worker involvement
Total quality management is a comprehensive management philosophy that integrates all organizational functions to focus on meeting customer needs. It requires active participation from every employee, from front-line workers to senior executives, to continuously improve processes and products. It shifts the responsibility of quality from an isolated inspection department to the entire organization.

202. (B) W. Edwards Deming
Dr. W. Edwards Deming formulated fourteen key principles that serve as the foundation for implementing total quality management. His philosophy emphasizes leadership, continuous process improvement, elimination of fear, and training to build long-term organizational quality. His teachings helped transform manufacturing quality standards globally, particularly in post-war Japan.

203. (A) Giving operators the training, tools, and authority to stop production if a defect is found
Empowering workforce members involves providing them with the necessary training, resources, and authority to take ownership of quality. On a dairy processing floor, this includes giving operators the power to halt production lines immediately if they detect a quality deviation. This proactive authority stops defects from propagating through subsequent stages.

204. (C) High external failure costs (e.g., recalls, lawsuits) are desirable because they generate free publicity
External failure costs arise when defective products reach the customer, leading to complaints, recalls, and potential lawsuits. These failures are highly damaging and expensive, causing severe financial losses and destroying brand reputation. TQM aims to minimize these failures by investing in prevention and appraisal activities to identify issues early.

205. (D) Recognizing that each department is a customer to the preceding step and deserves high quality
The internal customer concept recognizes that work processes consist of a chain of internal suppliers and customers. Each department must treat the subsequent step in the production line as a customer, ensuring they receive defect-free inputs. This perspective fosters collaboration, reduces errors, and aligns all operations toward satisfying the final consumer.

206. (A) Quality Planning, Quality Control, and Quality Improvement
Joseph Juran categorized quality management into three universal processes known as the Juran Trilogy. These include planning quality during product development, controlling processes to maintain standard performance, and actively improving quality to reach breakthrough levels. Implementing all three processes is necessary to manage quality systematically and reduce chronic waste.

207. (B) A cultural shift from reactive "detect and fix" to proactive "prevent and improve" at all levels
Successfully adopting total quality management transforms the organizational culture of a dairy processing facility. It shifts the operational focus from reactively detecting and fixing defects to proactively preventing errors and driving continuous improvement. This cultural change involves all employees, leading to higher product quality, lower waste, and increased efficiency.

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systematically planning changes, implementing them, monitoring the outcomes, and acting on results, businesses can sustain long-term quality improvements effectively.

172. (C) It specifically mandates the exact fat and SNF percentages for dairy products
The quality management standard is designed to be generic, meaning it can be applied to any organization regardless of industry, size, or product type. It focuses on process control, customer satisfaction, and continuous improvement rather than defining specific product compositions. Compositional parameters like fat levels are governed by national food standards instead of generic management standards.

173. (D) By assessing satisfaction, understanding buyer needs, and seeking to exceed expectations
Prioritizing the consumer involves actively gathering feedback, monitoring satisfaction levels, and adjusting processes to meet market requirements. A dairy organization achieves this by understanding consumer taste preferences, packaging needs, and safety expectations. This approach ensures that the business consistently delivers high-quality products that align with buyer demands and foster brand loyalty.

174. (C) Continuous improvement
Monitoring the decline of packaging errors over successive months demonstrates an ongoing commitment to enhancing process performance. This active measurement aligns with the core quality principle focused on making incremental improvements to systems and outputs. By systematically analyzing defect data and refining processes, organizations reduce waste, lower production costs, and improve overall product quality.

175. (B) The plant must analyze the root cause and implement corrective actions to prevent recurrence
When an internal or external audit reveals a deviation from established quality standards, the facility must take systematic corrective action. The quality team must analyze the underlying root cause of the failure rather than merely treating the immediate symptom. Implementing targeted corrective actions ensures that the non-conformity is prevented from recurring in future batches.

176. (D) It uses "Documented Information," giving organizations flexibility in record formats and mediums
The twenty fifteen revision of the standard modernized how organizations manage records by introducing the term documented information. This update removed the rigid requirement for specific documents like quality manuals, allowing businesses to use digital, electronic, or physical media. It provides flexibility to design documentation systems that best suit operational needs and technological infrastructure.

177. (B) P-3, Q-4, R-2, S-1
The high-level structure of the quality standard organizes requirements into logical sections. Clause four focuses on understanding the context of the organization, while clause five establishes leadership commitment and policy. Clause eight governs the operational planning and control of production, and clause nine details performance evaluation through internal audits and management reviews.

178. (C) Maximizing short-term profit
Quality management systems are built on long-term sustainability, customer satisfaction, and process improvement. Prioritizing short-term financial gains at the expense of quality is not recognized as a core guiding principle. The established principles emphasize leadership, engagement of people, process approaches, continuous improvement, evidence-based decision making, and relationship management to ensure organizational success.

179. (A) Management Review
Senior leadership must periodically evaluate the quality management system to ensure its continuing suitability, adequacy, and effectiveness. This formal process involves analyzing audit results, customer feedback, process performance, and strategic alignment with business goals. It provides a structured forum for making high-level decisions regarding resource allocation and continuous improvement opportunities within the organization.

180. (D) Food Safety Management Systems (FSMS) requirements across the entire food chain
This international standard specifies the requirements for a food safety management system that spans from primary production to final consumption. It provides a framework

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217. (D) Shitsuke – Standardize
The fifth stage of the workplace organization method is shitsuke, which translates to sustaining the standard through self-discipline and regular auditing. Standardizing these procedures corresponds to seiketsu, the fourth stage. Misunderstanding these translations can lead to a failure to maintain the clean, organized workplace conditions established in the initial phases.

218. (B) Lean cuts waste and improves flow, whereas Six Sigma reduces process variation and boosts precision
While both methodologies aim to improve operational performance, they target different process challenges. One framework focuses on mapping value streams, eliminating waste, and optimizing process flow to increase speed. The other relies on statistical analysis to minimize variation, eliminate defects, and improve precision. Integrating both approaches provides a comprehensive toolkit.

219. (A) Defect-free, value-added processing
Activities that physically transform raw materials into products that customers are willing to pay for represent value-added processing. These essential actions do not constitute waste within the efficiency improvement framework. The methodology targets non-value-added activities, such as excess overproduction, waiting times, and underutilized skills, for systematic reduction and elimination.

220. (C) It visually maps materials and information from supplier to consumer, exposing bottlenecks and waste
Value stream mapping is a visual tool used to document the flow of materials and information through the entire production process. It allows teams to identify waste, identify processing bottlenecks, and design a more efficient future-state flow. This comprehensive perspective ensures that improvement efforts target systemic issues rather than isolated steps.

221. (D) Global Food Safety Initiative
The Global Food Safety Initiative is an industry-driven collaboration established to advance food safety across the global supply chain. This non-profit organization benchmarks various food safety certification schemes to ensure they meet equivalent standards of safety assurance. Its work builds consumer trust and facilitates international trade by harmonizing standards.

222. (C) ISO 22000 combined with sector-specific PRPs and additional FSSC requirements
The comprehensive certification scheme combines the international food safety management standard with detailed, sector-specific prerequisite programs and additional scheme requirements. This integration provides a robust framework that is recognized globally by major retailers and food service companies. It ensures that manufacturing facilities maintain rigorous hygiene practices alongside structured management systems.

223. (B) Safe Quality Food
The abbreviation refers to the Safe Quality Food program, which is a global food safety and quality certification standard. Administered by the Food Marketing Institute, this program is designed to meet the rigorous safety requirements of retailers and buyers worldwide. It provides separate modules for primary production, food manufacturing, and distribution.

224. (D) It is a GFSI scheme focused on management commitment, HACCP, and facility prerequisites
The British Retail Consortium standard is a globally recognized food safety certification scheme benchmarked by the international food safety initiative. The standard places strong emphasis on senior management commitment, structured hazard analysis plans, and clean facility prerequisite programs. It helps manufacturers demonstrate compliance with regulatory and quality requirements across international markets.

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225. (A) To evaluate food safety schemes against standard criteria to ensure equivalent safety assurance
Benchmarking involves comparing different food safety certification programs against a standardized set of requirements known as the guidance document. This process ensures that various schemes, such as FSSC twenty-two thousand and SQF, provide equivalent levels of safety assurance. It harmonizes standards, allowing retailers to accept multiple certified programs without requiring duplicate audits.

208. (D) QC relies on final inspection of defects, whereas TQM builds quality into every stage of the process
Traditional quality control focuses on final inspection to identify and separate defective products before shipment. Total quality management represents a broader approach, focusing on building quality directly into every step of the design and manufacturing process. By preventing errors from occurring, this comprehensive philosophy reduces rework, waste, and overall production costs.

209. (A) Tolerating a steady baseline of defects
Total quality management operates under the belief that defects are preventable and that organizations should strive for zero errors. Tolerating an acceptable level of defects contradicts the core principle of continuous improvement. The philosophy emphasizes systematic process design, data-driven decisions, and employee engagement to eliminate errors from all business processes.

210. (C) Providing visible commitment, defining the vision, aligning resources, and leading quality efforts
Senior executives must actively lead the quality transformation by demonstrating a clear, visible commitment to continuous improvement. Their role involves defining the organizational vision, aligning financial and human resources, and establishing a supportive environment. Successful implementation fails when leadership delegates responsibility without providing active support and strategic direction.

211. (A) To relentlessly identify and eliminate waste from processes to maximize customer value
Lean manufacturing focus is centered on identifying and removing non-value-added activities, known as waste, from production processes. By streamlining operations and optimizing material flows, organizations can maximize customer value while using fewer resources. This efficiency focus helps dairy plants reduce lead times, lower operational costs, and improve overall product quality.

212. (A) Sort, Set in order, Shine, Standardize, Sustain
The workplace organization method consists of five sequential steps designed to create a clean, safe, and efficient environment. These stages involve sorting through items, setting necessary tools in order, shining the workspace through cleaning, standardizing these practices, and sustaining the improvements over time. This methodology reduces waste and improves safety.

213. (B) A philosophy of continuous, incremental improvement involving all levels of workforce
Kaizen is a Japanese philosophy that translates to change for the better, focusing on continuous improvement. This approach encourages small, low-cost, incremental changes to processes made by employees at all levels of the organization. By fostering a culture of constant refinement, businesses can achieve significant cumulative improvements in quality and efficiency.

214. (C) Mistake-proofing steps so that human processing errors are made impossible or immediately clear
Poka-yoke represents mistake-proofing mechanisms designed to prevent human errors from occurring during manufacturing processes. By integrating physical or procedural constraints into the production line, these devices make it impossible to execute a step incorrectly. If an error does occur, the system provides immediate feedback to halt the process.

215. (D) Mura (Unevenness / Inconsistency)
The Japanese term identifies the waste of unevenness or inconsistency in production levels and scheduling. This variation causes fluctuating workloads that can strain machinery and employees, leading to defects and safety issues. Addressing this waste requires leveling production schedules to create a smooth, predictable flow of materials through the plant.

216. (A) Receiving packaging materials only as needed, cutting storage costs and inventory obsolescence
Implementing a pull-based inventory system ensures that packaging supplies are delivered precisely when needed for production. This approach minimizes the capital tied up in warehousing large volumes of materials and reduces the risk of inventory damage or obsolescence. It relies on reliable supplier partnerships and precise scheduling to maintain continuous operations.

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